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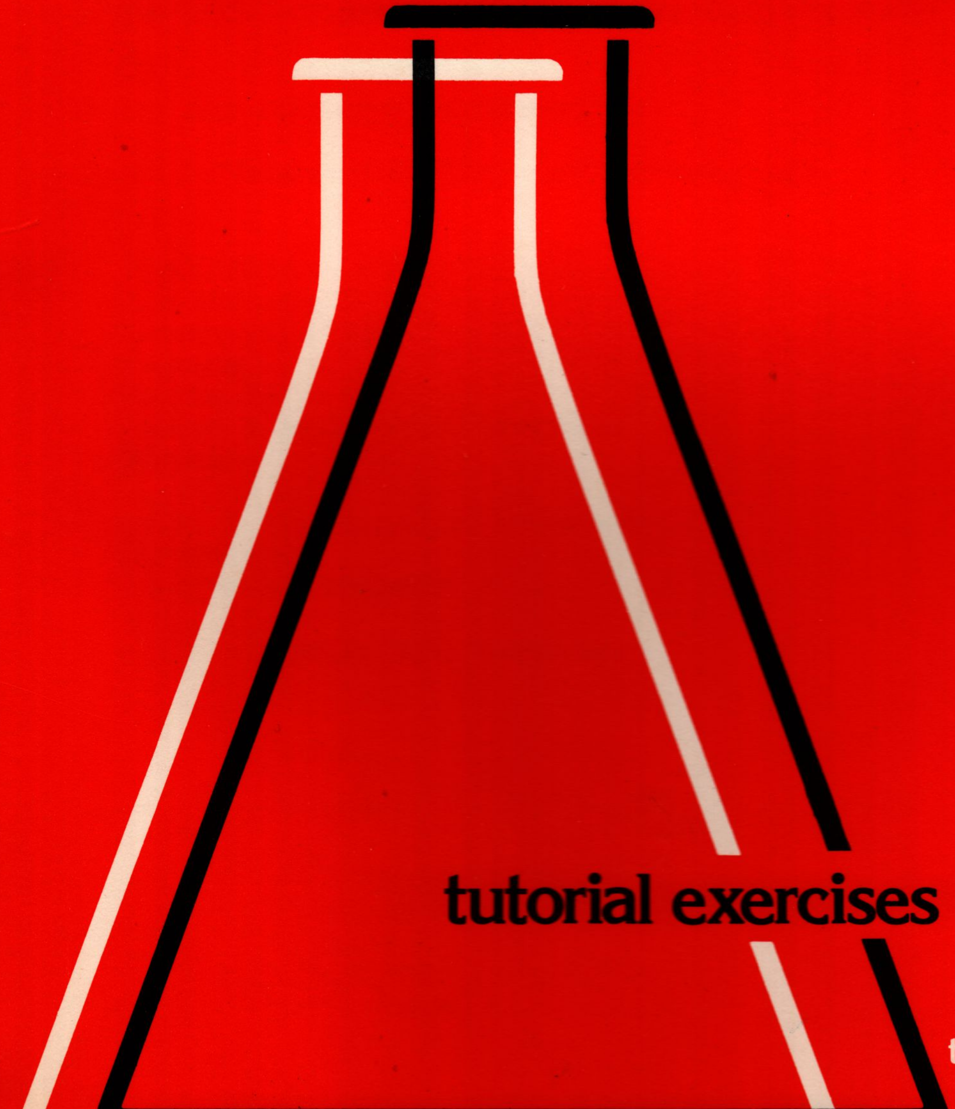
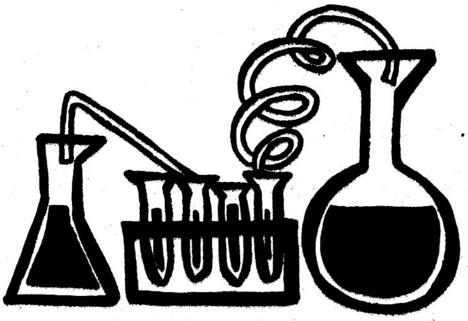


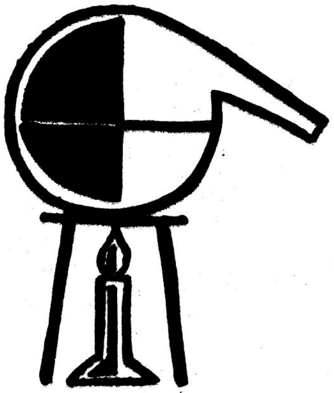
tutorial exercises for chemistry

teacher's resource guide

written by paul cauchon
canterbury school



TUTORIAL EXERCISES FOR CHEMISTRY
TEACHER'S RESOURCE GUIDE



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ACKNOWLEDGEMENTS

I wish to thank Chris Doyle and the 1972-73 Chemistry students of Canterbury School for their help in bringing this manuscript to its final form. They patiently and sometimes even gleefully unearthed the bugs in the programs and offered numerous suggestions for making each exercise more effective.

Paul Cauchon
August, 1973

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PRICE: $3.50

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INTRODUCTION

GENERALLY SPEAKING

TUTORIAL EXERCISES FOR CHEMISTRY is a collection of computer-based interactive learning exercises devoted to some of the basic principles and relationships presented in introductory chemistry courses. The student and the computer communicate throughout each exercise, with the computer's response dependent upon the student's input. Progress made in a program is dependent upon mastery of intermediate steps. These programs enable a student to grasp a topic at his own rate and in his own manner by taking advantage of the speed, accuracy and versatility (not to mention the patience!) of a computer. They do not, however, require a sizeable commitment in terms of special hardware, extensive storage capabilities, or specially trained personnel. The size and structure of these programs make them usable with virtually any BASIC Compiler.

The exercises are not interdependent, nor do they pretend to provide new or original instruction. Each is designed to reinforce understanding of a single topic or concept that has been previously discussed.

In each exercise the presentation varies each time the program is run so that every student receives his own set of questions. Numerical values for problems vary randomly within logical limits; the same problem is never presented twice, either within an exercise or from one run to the next.

Both student and teacher receive immediate feedback from these exercises. In those cases where students encounter difficulties, explanations and additional questions are provided. For the teacher, the exercise sheets are self-grading, and student errors are immediately recognizable.

The computer has been adapted by these exercises to drill science students in the use of certain concepts with a degree of individual attention which is impossible to attain in the normal classroom situation.

FEATURES OF THE EXERCISES

In each sequence of questions, careful attention has been given to the wording and selection of examples in order to focus attention on the basic idea in a straight-forward manner. Few, if any, of the problems deal with the "exceptions" to the general rules. To enable the student to concentrate on the chemistry of a problem, each exercise involving problem-solving contains math subroutines to assist with the required calculations.

The student must determine the specific arithmetic operations for each problem but the actual computations can be done by the computer.

Another feature built into each program causes the computer to pause whenever an explanation is printed in response to an incorrect answer. The student is encouraged to study the problem and identify his mistake before restarting the exercise.

Every problem provides the student with his score after a specific number of questions have been answered. In many cases, a student will repeat an exercise to improve his first score. It is not unusual to find students repeating an exercise three or four times to score 100% and a "victory" over the machine!

COMPUTER ORIENTATION REQUIREMENTS

These exercises were designed for all students in any chemistry course; no special instruction in the use or programming of computers is required either by the student or the teacher. The Student Handbook contains descriptions and instructions to help students use the exercises.

INCORPORATING THE EXERCISES

The sequence in which the programs have been arranged is arbitrary; they may be used in any sequence which is appropriate to the course syllabus. A cross reference key to fifteen commonly used chemistry texts has been included in this guide for ease in integrating the material into the curriculum.

Program modification may be necessary, depending on the BASIC compiler that is used. Appendix A of this volume deals with the most common changes that may be required.

APPLICATIONS

There are three ways in which the programs can be used:

1) CLASS ASSIGNMENTS (in place of the conventional "first ten problems at the end of the chapter".)

2) REMEDIAL WORK (for students who have missed work or need additional drill on certain topics.)

3) REVIEW FOR EXAMINATIONS

ORGANIZATION OF THE EXERCISES

Each of the ten exercises in this volume is organized in the following manner:

DESCRIPTION

- Program Topic and Objectives

DISCUSSION

- Question Format
- Scoring

PREPARATION

- Background Information
- Materials
- Time Requirements

DOCUMENTATION

- Sample Run
- Program Listing
- Modification Notes

SUMMARY

These exercises represent a relatively new approach to certain aspects of instruction, made possible by the vast improvements in computer technology which have enabled so many schools to acquire this valuable learning tool. Comments concerning the effectiveness of these programs, suggestions for their improvement, and observations of student reactions are earnestly solicited and will be gratefully acknowledged.

THE EXERCISES

I: METEST

DESCRIPTION

This program gives practice with metric system units for measuring length, mass and volume. It consists of a sequence of multiple choice conversion problems that utilize the units most frequently encountered in science courses.

DISCUSSION

QUESTION FORMAT: The program generates nine different questions and appropriate multiple choice answers in each sequence. For example:

```
TO CHANGE CENTIMETERS TO METERS YOU SHOULD:
(A)MULTIPLY BY 100  (B)MULTIPLY BY 10  (C) DIVIDE BY 100
(D)DIVIDE BY 10

16.42 CENTIMETERS= ? MM
(A)  1642     (B)  164.2     (C)  16420     (D)  1.642

10.18 GRAMS = ? KG
(A)  1.018E-2    (B)  1.018E-1    (C)  1018    (D)  10180

7.74 METERS = ? CM
(A)  .774    (B)  77.4    (C)  774    (D)  7.74E-2

13.91 ML  =? CC
(A)  1391     (B)  13.91     (C)  .1391     (D)  1.391E-2

WHICH IS THE SMALLEST?
(A)  580 GMS    (B)  5.8E-2 KG    (C)  2900 MILLIGMS

3 LITERS = ? CC
(A)  300     (B)  3E-2     (C)  3000     (D)  30

WHICH IS THE LARGEST?
(A)  332 METERS    (B) 4150 CM     (C)  .166 KM

14.48 POUNDS = ? KILOGRAMS
(A)  7240     (B)  6.58182     (C)  31.856     (D)  3.18242E-2
```

With each run of the program, the order of the questions is scrambled, and the numerical values are selected at random.

SCORING: When a student answers a question incorrectly he is told to try it again and his error is tallied. If he misses the second attempt an additional half-error is counted against him. He is given the correct answer with a brief explanation, and the program waits for him to study his mistake. When he restarts by pressing 'RETURN', he gets the same question with new numerical values.

After all nine questions have been answered, the student's score is computed as follows:

$$\frac{(T - E)}{T} \times 100\ \%$$

where T = total number of questions asked including "repeats"
E = error count

After seeing his score, the student may start again with a new sequence.

PREPARATION

BACKGROUND: This exercise is designed to be used very early in the year after the metric system has been introduced in class. It is also a good review for students in courses where familiarity with the metric system is assumed as a prerequisite. Before the exercises are assigned, students should have a thorough understanding of exponential notation. For example,

9.4E-2 means 9.4×10^{-2} or .094

1E-4 means 1×10^{-4} or .0001

TIME REQUIREMENT: Approximately 30 minutes/student

DOCUMENTATION

SAMPLE RUN:

```
RUN


METEST  CANTERBURY

PLEASE TYPE YOUR FULL NAME


WILLIAM WILLIAMS
```

```
Q.  1 .

 8.65 GRAMS = ? KG
(A)  8.65E-3   (B)  8.65E-2   (C)  865   (D)  8650

A

RIGHT

Q.  2 .

 17.84 ML = ? CC
(A)  1784    (B)  17.84     (C)  .1784    (D)  1.784E-2

A

NO - TRY IT AGAIN.


A
NO;  17.84  IS RIGHT, SINCE A CC IS THE SAME AS A ML!


STUDY THAT, THEN PRESS 'RETURN'

 7.29 ML = ? CC
(A)  729    (B)  7.29     (C)  7.29E-2    (D)  7.29E-3

B

RIGHT

Q.  3 .

WHICH IS THE LARGEST?
(A)  264 METERS   (B)  3300 CM   (C)  .132 KM


C

NO - TRY IT AGAIN.


Z
STILL NO!  3300 CM= 33 METERS,  .132 KM= 132 METERS,
SO  264 METERS IS THE ANSWER.


STUDY THAT, THEN PRESS 'RETURN'

WHICH IS THE LARGEST?
(A)  784 METERS   (B)  9800 CM   (C)  .392 KM
```

```
A

RIGHT

Q.  4 .

 5.6  LITERS = ? CC
(A) 560     (B)  5.6E-2    (C) 5600     (D)  56


C

RIGHT

Q.  5 .

WHICH IS THE SMALLEST?
(A)  1930 GMS  (B)  .193 KG  (C)  9650 MILLIGMS


C

RIGHT

Q.  6 .

 6.62 CENTIMETERS= ? MM
(A)  662     (B)  66.2     (C)  6620     (D)  .662


B

RIGHT
 .
 .
 .
```

PROGRAM LISTING:

```
10RANDOMIZE
11DIMP(40)
20PRINT"PLEASE TYPE YOUR FULL NAME"\PRINT
25PRINT
27INPUT$P(M)
30IFP(M)=32THEN 40
35IFP(M)=13THEN50
36GOTO41
40S=M
41M=M+1
45GOTO27
.
```

ACCEPT STUDENT'S NAME

```
50PRINT
120W=1
215GOTO2000
216PRINT
217X=0
218N=0
220I=I+1
221IFI>9THEN1610     JUMP TO SCORE COMPUTATION
222PRINT"Q. "I"."  } PRINT QUESTION NUMBER AND SELECT QUESTION
230GOTO2100        }
250N=N+1\Y=0   INCREMENT COUNTER, RESET Y
265Q=INT(RND(1)*200+10)/10
270PRINT"WHICH IS THE LARGEST?"
271PRINT"(A) "40*Q"METERS    (B) "500*Q"CM    (C) ".02*Q"KM"
280GOSUB1880   INPUT RESPONSE
290IFZ=65THEN1730   COMPARE ANSWER                QUESTION
310IFY=1THEN350\Y=1
330GOSUB1660   TALLY WRONG ANSWER,
340GOTO280     GIVE SECOND TRY
350PRINT"STILL NO! "500*Q"CM="5*Q"METERS, ".02*Q"KM="20*Q"METERS,"
351PRINT"SO "40*Q"METERS IS THE ANSWER."
360GOSUB2500
380GOTO250    RESTATE QUESTION
400N=N+1\Y=0
415Q=INT(RND(1)*200+10)/10
420PRINT"WHICH IS THE SMALLEST?"
421PRINT"(A) "100*Q"GMS   (B) ".01*Q"KG   (C) "500*Q"MILLIGMS"
430GOSUB1880
440IFZ=67THEN1730
460IFY=1THEN500\Y=1                               QUESTION
480GOSUB1660
490GOTO430
500PRINT"NO- ".01*Q"KG="10*Q"GMS, AND "500*Q"MILLIGRAMS="
501PRINT.5*Q"GMS, SO "500*Q"MG IS THE ANSWER."
510GOSUB2500
530GOTO400
550N=N+1\Y=0
570W=-W\IFW<0THEN575\PRINT"TO CHANGE METERS TO CENTIMETERS YOU SHOULD:"
571K=65\GOTO580
575PRINT"TO CHANGE CENTIMETERS TO METERS YOU SHOULD:"\K=67
580PRINT"(A)MULTIPLY BY 100  (B)MULTIPLY BY 10  (C)DIVIDE BY 100"
581PRINT"(D)DIVIDE BY 10"
590GOSUB1880                                      QUESTION
600IFZ=KTHEN1730
620IFY=1THEN660\Y=1
640GOSUB1660
650GOTO590
660PRINT"NO; "CHR$(K)" IS RIGHT SINCE 100 CM = 1 METER."
670GOSUB2500
690GOTO550
710N=N+1\Y=0
720Y=0
730GOSUB 1700
740PRINTQ "METERS = ? CM"
741PRINT"(A) "Q/10"  (B) "Q*10  "  (C) "Q*100"   (D) "Q/100
750GOSUB1880
760IFZ=67THEN1730                                 QUESTION
780IFY=1THEN820\Y=1
790GOSUB1660
810GOTO750
820PRINT"NO - YOU MULTIPLY BY 100 TO GET "Q*100
```

```
830GOSUB2500
840GOTO710
860N=N+1\Y=0
880 GOSUB 1700
890PRINTQ"GRAMS = ? KG"
891PRINT"(A) "Q/1000"  (B) "Q/100"  (C) "Q*100"  (D) "Q*1000
900GOSUB1880
910IFZ=65THEN1730
930IFY=1THEN970\Y=1                    QUESTION
940GOSUB1660
960GOTO890
970PRINT"NO; DIVIDE BY 1000 TO GET "Q/1000
980GOSUB2500
990 GOTO860
1010N=N+1\Y=0
1030 GOSUB 1700
1040PRINTQ"ML = ? CC"
1041PRINT"(A) "Q*100"   (B) "Q"    (C) "Q/100"   (D) "Q/1000
1050GOSUB1880
1060IFZ=66THEN1730
1080IFY=1THEN1120\Y=1                  QUESTION
1090GOSUB1660
1110GOTO1050
1120PRINT"NO; "Q" IS RIGHT, SINCE A CC IS THE SAME AS A ML!"
1130GOSUB2500
1140 GOTO 1010
1160N=N+1\Y=0
1180GOSUB 1700
1190PRINTQ"CENTIMETERS= ? MM"
1191PRINT"(A) "Q*100"   (B) "Q*10"   (C) "Q*1000"   (D) "Q/10
1200GOSUB1880
1210IFZ=66THEN1730
1230IFY=1THEN1270\Y=1
1250GOSUB1660                          QUESTION
1260GOTO1200
1270PRINTQ*10" IS CORRECT BECAUSE 1 CM =10 MM"
1280GOSUB2500
1290GOTO1160
1310N=N+1\Y=0
1330GOSUB1700
1340PRINTQ" LITERS = ? CC"
1341PRINT"(A)"Q*100"   (B) "Q/100"   (C)" Q*1000"   (D) "Q*10
1350GOSUB1880
1360IFZ=67THEN1730
1380IFY=1THEN1420\Y=1                  QUESTION
1400GOSUB1660
1410 GOTO 1340
1420PRINT"1000CC = 1000ML = 1 LITER, SO"Q*1000" IS THE ANSWER"
1430GOSUB2500
1440GOTO1310
1460N=N+1\Y=0
1480GOSUB 1700
1490PRINTQ" POUNDS = ? KILOGRAMS"
1491PRINT"(A) "Q*500"   (B) "Q/2.2"   (C) "Q*2.2"   (D) "Q/455
1500GOSUB1880
1510IFZ=66THEN1730
1530IFY=1THEN1570\Y=1                  QUESTION
1550GOSUB1660
1560GOTO1500
1570PRINTQ/2.2" IS RIGHT, SINCE 2.2 LBS = 1 KG."
1580GOSUB2500
1590 GOTO1460
```

```
1610PRINT"WELL, ";                          SCORE COMPUTED, CONTINUE OPTION
1611GOSUB3000
1615PRINT", YOUR SCORE IS NOW "INT(((N-X)/N*100+.05)*10)/10"%."
1620PRINT"WANT TO TRY SOME MORE (Y OR N)?";
1630INPUT$Z
1635PRINT
1636I=0
1640IFZ=89THEN215
1650 STOP
1660PRINT\X=X+1\PRINT"NO - TRY IT AGAIN."\PRINT\RETURN  WRONG ANSWER ROUTINE
1700 LET Q=INT(2000*RND(0))/100  RANDOM NUMBER CHOSEN
1720 RETURN
1730 FOR E=1 TO 7
1740PRINTCHR$(135);
1750 NEXT E              RING BELL, ACKNOWLEDGE CORRECT ANSWER,
1760PRINT                GO BACK FOR NEW QUESTION
1770PRINT"RIGHT"
1780PRINT
1790GOTO220
1880PRINT\PRINT\INPUT$Z\PRINT\RETURN   ROUTINE FOR ACCEPTING ANSWER
2000I=I+1
2010N(I)=INT(RND(1)*9+1)
2020FOR J=1 TO I-1
2025IFN(I)=N(J)THEN2010    SCRAMBLING SEQUENCE
2030NEXTJ
2040IFI<9THEN2000
2050I=0
2060GOTO216
2100PRINT
2101IFN(I)=1THEN250
2102IFN(I)=2THEN400
2103IFN(I)=3THEN550
2104IFN(I)=4THEN710      TO SELECT  QUESTION
2105IFN(I)=5THEN860
2106IFN(I)=6THEN1010
2107IFN(I)=7THEN1160
2108IFN(I)=8THEN1310
2109GOTO1460
2500PRINT\PRINT\PRINT"STUDY THAT, THEN PRESS 'RETURN'"  PAUSE ROUTINE
2505PRINT\X=X+.5
2515INPUT$Z
2517PRINT
2520RETURN
3000FORJ=0TOS
3010PRINTCHR$(P(J));     PRINT FIRST NAME
3020NEXTJ
3030RETURN
4000END

READY
```

DEFINITION OF VARIABLES:

N - the number of questions asked

I - the number of different question types asked

Y - a flag (0 or 1 to indicate that the wrong answer has been given)

X - error counter

Q - a randomly selected number which forms the basis of each problem

W - a flag (1 or -1 to control the form of the question)

Z - the student's response

K - the correct response to one of the questions

P, M, S - used in setting up student's name

S - the number of letters in first name

II: DENSITY

DESCRIPTION

This exercise deals with the concept of density. Five different problems are presented, involving the relationships between the fundamental physical quantities of mass, volume and density. Each problem requires some application of the formula:

$$\text{DENSITY} = \frac{\text{MASS}}{\text{VOLUME}}$$

DISCUSSION

QUESTION FORMAT: The five questions are of the following form:

(A) A BLOCK IS *** CM LONG, *** CM WIDE, *** CM THICK AND WEIGHS *** GMS; WHAT IS ITS DENSITY?

(B) WITH *** ML OF WATER IN A GRADUATED CYLINDER, A METAL OBJECT WEIGHING *** GMS IS SUBMERGED, AND THE LEVEL RISES TO *** ML. FIND THE DENSITY OF THE OBJECT.

(C) IF *** NAILS RAISE THE WATER LEVEL IN A GRADUATED CYLINDER BY *** ML, AND THE DENSITY OF THE METAL IN THE NAILS IS 7.2 GMS PER CC, WHAT DOES ONE NAIL WEIGH?

(D) A SHEET OF LEAD *** CM LONG, AND *** CM WIDE WEIGHS *** GMS. LEAD'S DENSITY IS 11.3 GMS/CC. HOW THICK IS THE LEAD SHEET?

(E) IF *** ML OF GASOLINE WEIGH *** GMS, WHAT VOLUME OF GAS WOULD YOU NEED FOR *** GMS?

They are presented in the order shown and the values inserted at the *** are selected at random. If a question is answered incorrectly, an explanation is given,and the program pauses so the student may study it. When the student restarts the program the same question is repeated using different values. After Question E has been answered correctly, the sequence starts over again unless the student has answered all questions correctly on the first try. In that case he receives a score of 100%,and the program stops.

The error tolerance on each problem is 2 percent. This allows the optional use of a slide rule in place of the math help subroutine.

SCORING: The score is computed as follows:

$$\frac{B - X}{B} \times 100\%$$

Where B = total number of questions asked
X = number of incorrect responses

PREPARATION

BACKGROUND: This exercise can be assigned early in an introductory chemistry, physics, or physical science course to students not already proficient with metric units or concepts of mass, volume and density. The computer's form of exponential notation should be discussed before running the program, since some calculations will be expressed in the form 2.34E-2 rather than .0234.

TIME REQUIREMENT: Approximately 30 minutes/student.

DOCUMENTATION

SAMPLE RUN:

```
RUN


DENSIT  CANTERBURY

PLEASE TYPE YOUR FULL NAME


MILTON COLVIN

 1 ) A BLOCK IS 73 CM LONG,  57.4 CM WIDE,
 37.6 CM THICK AND WEIGHS  12400 GMS; WHAT IS ITS DENSITY?


WANT SOME HELP WITH THE MATH(Y OR N)7
PLEASE ANSWER Y OR N
WANT SOME HELP WITH THE MATH(Y OR N)Y
:
:
ANS. IN G/CC=?127051
NO-
MULTIPLY THE DIMENSIONS TO GET THE VOLUME, THEN DIVIDE THE
MASS BY THE VOLUME TO GET  7.87044E-2  FOR THE DENSITY IN GMS/CC


STUDY THAT, THEN PRESS 'RETURN'.
```

```
 2 ) A BLOCK IS 320 CM LONG,  65.8 CM WIDE,
 11.6 CM THICK AND WEIGHS  156400 GMS; WHAT IS ITS DENSITY?


WANT SOME HELP WITH THE MATH(Y OR N)Y
⋮
ANS. IN G/CC=?1.56
NO-
MULTIPLY THE DIMENSIONS TO GET THE VOLUME, THEN DIVIDE THE
MASS BY THE VOLUME TO GET  .640329  FOR THE DENSITY IN GMS/CC


STUDY THAT, THEN PRESS 'RETURN'.

 3 ) A BLOCK IS 303 CM LONG,  56.2 CM WIDE,
 9.6 CM THICK AND WEIGHS  155200 GMS; WHAT IS ITS DENSITY?


WANT SOME HELP WITH THE MATH(Y OR N)N
ANS. IN G/CC=?.640329
NO-
MULTIPLY THE DIMENSIONS TO GET THE VOLUME, THEN DIVIDE THE
MASS BY THE VOLUME TO GET  .949383  FOR THE DENSITY IN GMS/CC


STUDY THAT, THEN PRESS 'RETURN'.

 4 ) A BLOCK IS 34 CM LONG,  48.6 CM WIDE,
 22.9 CM THICK AND WEIGHS  77200 GMS; WHAT IS ITS DENSITY?


WANT SOME HELP WITH THE MATH(Y OR N)
PLEASE ANSWER Y OR N
WANT SOME HELP WITH THE MATH(Y OR N)Y
MULTIPLICATION OR DIVISION?(M OR D)M
FIRST NUMBER?34
SECOND NUMBER?49
 34 X 49 = 1666
NEED ANY MORE HELP?(Y OR N)Y
MULTIPLICATION OR DIVISION?(M OR D)M
FIRST NUMBER?1666
SECOND NUMBER?23
 1666 X 23 = 38318
NEED ANY MORE HELP?(Y OR N)Y
MULTIPLICATION OR DIVISION?(M OR D)D
WHAT IS THE DIVISOR?38318
WHAT IS THE DIVIDEND?77200
 77200 / 38318 = 2.01472
NEED ANY MORE HELP?(Y OR N)N
ANS. IN G/CC=?2.014
RIGHT!!



 5 )WITH 46.2 ML OF WATER IN A GRADUATED CYLINDER, A METAL
OBJECT WEIGHING 175 GMS IS SUBMERGED, AND THE LEVEL
RISES TO  90.5 ML. FIND THE DENSITY OF THE OBJECT.
```

```
WANT SOME HELP WITH THE MATH(Y OR N)Y
!
!
!
ANS. IN G/CC=?3.24
NO-
THE DIFFERENCE BETWEEN THE WATER LEVELS IS THE VOLUME, SO
DIVIDE THIS INTO THE MASS AND YOU GET THE DENSITY,  3.95034 GMS/CC.


STUDY THAT, THEN PRESS 'RETURN'.

 6 )WITH 46.5 ML OF WATER IN A GRADUATED CYLINDER, A METAL
OBJECT WEIGHING 178.5 GMS IS SUBMERGED, AND THE LEVEL
RISES TO  91.8 ML. FIND THE DENSITY OF THE OBJECT.


WANT SOME HELP WITH THE MATH(Y OR N)D
PLEASE ANSWER Y OR N
WANT SOME HELP WITH THE MATH(Y OR N)Y
MULTIPLICATION OR DIVISION?(M OR D)D
WHAT IS THE DIVISOR?45.3
WHAT IS THE DIVIDEND?178.5
 178.5 / 45.3 = 3.9404
NEED ANY MORE HELP?(Y OR N)N
ANS. IN G/CC=?3.94
RIGHT!!



 7 ) IF  19  NAILS RAISE THE WATER LEVEL IN A GRADUATED
CYLINDER BY 25.2 ML, AND THE DENSITY OF THE METAL IN THE
NAILS IS 7.2 GM/CC, WHAT DOES ONE NAIL WEIGH?


WANT SOME HELP WITH THE MATH(Y OR N)N
ANS. IN GMS=?3.94
NO-
FIND THE VOLUME OF ONE NAIL BY DIVIDING THE VOLUME OF ALL THE
NAILS BY THE NUMBER OF NAILS; MULTIPLY THIS BY THE DENSITY
OF THE METAL AND YOU GET 9.54948  GMS FOR THE MASS OF ONE NAIL


STUDY THAT, THEN PRESS 'RETURN'.

 8 ) IF  14  NAILS RAISE THE WATER LEVEL IN A GRADUATED
CYLINDER BY 20.2 ML, AND THE DENSITY OF THE METAL IN THE
NAILS IS 7.2 GM/CC, WHAT DOES ONE NAIL WEIGH?


WANT SOME HELP WITH THE MATH(Y OR N)Y
!
'
!
!
ANS. IN GMS=?10
NO-
FIND THE VOLUME OF ONE NAIL BY DIVIDING THE VOLUME OF ALL THE
NAILS BY THE NUMBER OF NAILS; MULTIPLY THIS BY THE DENSITY
OF THE METAL AND YOU GET 10.3885  GMS FOR THE MASS OF ONE NAIL
```

```
STUDY THAT, THEN PRESS 'RETURN'.

 9 ) IF  21  NAILS RAISE THE WATER LEVEL IN A GRADUATED
CYLINDER BY 26.1 ML, AND THE DENSITY OF THE METAL IN THE
NAILS IS 7.2 GM/CC, WHAT DOES ONE NAIL WEIGH?


WANT SOME HELP WITH THE MATH(Y OR N)Y
!
'
'
ANS. IN GMS=?8
NO-
FIND THE VOLUME OF ONE NAIL BY DIVIDING THE VOLUME OF ALL THE
NAILS BY THE NUMBER OF NAILS; MULTIPLY THIS BY THE DENSITY
OF THE METAL AND YOU GET 8.94857  GMS FOR THE MASS OF ONE NAIL


STUDY THAT, THEN PRESS 'RETURN'.

 10 ) IF  31  NAILS RAISE THE WATER LEVEL IN A GRADUATED
CYLINDER BY 4.1 ML, AND THE DENSITY OF THE METAL IN THE
NAILS IS 7.2 GM/CC, WHAT DOES ONE NAIL WEIGH?
'
'
'
'
'
OKAY,MILTON , YOUR SCORE IS  38.5 %.

READY
```

PROGRAM LISTING:

```
10RANDOMIZE
11DIMP(40)
20PRINT"PLEASE TYPE YOUR FULL NAME"\PRINT
25PRINT
27INPUT$P(M)
30IFP(M)=32 THEN 40
35IFP(M)=13THEN50                    } INPUT STUDENT'S NAME
36GOTO41
40S=M
41M=M+1
45GOTO27
50PRINT
130DIM N(6),R(14)
160 GOSUB1740                        } SET UP VALUES FOR PROBLEMS
170PRINT
```

```
180B=B+1
190PRINT B") A BLOCK IS"10*R(1)"CM LONG, "2*R(2)"CM WIDE,"
200PRINTR(3)"CM THICK AND WEIGHS "4000*R(4)"GMS; WHAT IS ITS DENSITY?"
210PRINT\PRINT\GOSUB1470
240PRINT"ANS. IN G/CC=";                  QUESTION A (180 - 380)
250INPUT Z
260K=200*R(4)/(R(1)*R(2)*R(3))
270IFABS(Z-K)<.02*KTHEN360
290GOSUB1370
320PRINT"MULTIPLY THE DIMENSIONS TO GET THE VOLUME, THEN DIVIDE THE"
330PRINT"MASS BY THE VOLUME TO GET "K" FOR THE DENSITY IN GMS/CC"
335GOSUB1800
340GOSUB1740
350 GOTO170
360GOSUB1410
370PRINT
380PRINT
390 B=B+1
400PRINT B")WITH"20+R(5)"ML OF WATER IN A GRADUATED CYLINDER, A METAL"
410PRINT"OBJECT WEIGHING"5*(R(6)+10)"GMS IS SUBMERGED, AND THE LEVEL"
420PRINT"RISES TO "30+R(5)+R(7)"ML. FIND THE DENSITY OF THE OBJECT."
430PRINT\PRINT\GOSUB1470
460PRINT"ANS. IN G/CC=";
470INPUT Z                                 QUESTION B (390 - 580)
480K=5*(R(6)+10)/(R(7)+10)
490IFABS(Z-K)<.02*KTHEN580
510GOSUB1370
540PRINT"THE DIFFERENCE BETWEEN THE WATER LEVELS IS THE VOLUME, SO"
550PRINT"DIVIDE THIS INTO THE MASS AND YOU GET THE DENSITY, "K"GMS/CC."
555GOSUB1800
560GOSUB1740
570GOTO380
580GOSUB1410
590PRINT
600PRINT
610B=B+1
619N1=INT(R(8)+10)
620PRINTB") IF "N1" NAILS RAISE THE WATER LEVEL IN A GRADUATED"
630PRINT"CYLINDER BY"R(9)"ML, AND THE DENSITY OF THE METAL IN THE "
640PRINT"NAILS IS 7.2 GM/CC, WHAT DOES ONE NAIL WEIGH?"
650PRINT\PRINT\GOSUB1470
680PRINT"ANS. IN GMS=";                     QUESTION C (600 - 830)
690INPUT Z
700K=R(9)*7.2/(INT(R(8)+10))
710IFABS(Z-K)<.02*KTHEN810
730GOSUB1370
760PRINT"FIND THE VOLUME OF ONE NAIL BY DIVIDING THE VOLUME OF ALL THE"
770PRINT"NAILS BY THE NUMBER OF NAILS; MULTIPLY THIS BY THE DENSITY"
780PRINT"OF THE METAL AND YOU GET"K" GMS FOR THE MASS OF ONE NAIL"
785GOSUB1800
790GOSUB1740
800 GOTO600
810GOSUB1410
820PRINT
830PRINT
840B=B+1
850PRINTB") A SHEET OF LEAD "R(10)+40"CM LONG AND "R(10)+15"CM WIDE"
860PRINT"WEIGHS "R(11)+300"GMS. LEAD'S DENSITY IS 11.3 GM/CC.  HOW"
870PRINT"THICK IS THE LEAD SHEET?"
880PRINT\PRINT\GOSUB1470
910PRINT"ANSWER IN CM=";
```

```
920INPUT Z
930K=(R(11)+300)/11.3/((R(10)+15)*(R(10)+40))
940IFABS(Z-K)<.02*KTHEN1030
960GOSUB1370
990PRINT"FIND THE VOLUME BY M/D; THEN FIND THE AREA; THEN DIVIDE THE"
1000PRINT"AREA INTO VOLUME TO GET THE THICKNESS, "K"CM."
1005GOSUB1800
1010GOSUB1740                        QUESTION D (840 - 1050)
1020GOTO830
1030GOSUB1410
1040PRINT
1050PRINT
1060B=B+1
1070PRINT B") IF"R(13)"ML OF GASOLINE WEIGH".78*R(13)"GMS, WHAT VOLUME"
1080PRINT"OF GAS WOULD YOU NEED FOR "100*(R(12))"GRAMS?"
1090PRINT\PRINT\GOSUB1470
1120PRINT"ANSWER IN ML=";
1130 INPUT Z
1140K=100*(R(12))/.78
1150IFABS(Z-K)<.02*KTHEN1240
1170GOSUB1370
1200PRINT"ONE ML OF GAS WEIGHS".78*R(13)"GMS DIVIDED BY "R(13)"ML"
1210PRINT"OR .78 G/CC.  DIVIDING THIS INTO THE MASS GIVES"K"ML"
1215GOSUB1800
1220GOSUB1740                        QUESTION E (1060 - 1260)
1230GOTO1050
1240 GOSUB1410
1250PRINT
1260PRINT
1261IFX=0THEN1270  END PROGRAM IF NO ERRORS TO THIS POINT
1265IFB<9THEN170   RESTART IF 9 QUESTIONS OR LESS
1270PRINT"OKAY,";
1271GOSUB3000
1275PRINT", YOUR SCORE IS "INT(((B-X)/B*100+.05)*10)/10"%."
1280PRINT\PRINT\PRINT\STOP   PRINT SCORE AND STOP
1370X=X+1
1380PRINT"NO-"               TALLY ERROR SUBROUTINE
1400 RETURN
1410FOR E=1 TO 5
1420PRINT CHR$(135);         RING BELL, PRINT "RIGHT" ON CORRECT ANSWER
1430 NEXT E
1440PRINT"RIGHT!!"
1450 PRINT
1460 RETURN
1470PRINT"WANT SOME HELP WITH THE MATH(Y OR N)";
1480INPUT $Z
1490 PRINT
1495IFZ=#NTHEN1730
1500IFZ=89THEN1510
1505PRINT"PLEASE ANSWER Y OR N"
1506GOTO1470
1510 PRINT"MULTIPLICATION OR DIVISION?(M OR D)";
1530 INPUT $Z
1535PRINT
1540 IF Z=77 THEN 1630        MATH HELP SUBROUTINE
1541IFZ=#D THEN1550
1542PRINT"PLEASE ANSWER M OR D";
1543GOTO1530
1550PRINT"WHAT IS THE DIVISOR";
```

```
1560 INPUT D1
1570PRINT"WHAT IS THE DIVIDEND";
1580INPUT D2
1590PRINTD2"/"D1"="D2/D1
1600PRINT"NEED ANY MORE HELP?(Y OR N)";
1620GOTO1480
1630PRINT"FIRST NUMBER";
1640INPUT W
1650PRINT"SECOND NUMBER";
1660INPUTW1
1710PRINTW"X"W1"="W*W1
1720GOTO1600
1730RETURN
1740FORI=1TO14
1760R(I)=INT(RND(1)*400+1)/10         CHOOSE ALL 14 VALUES FOR THE PROBLEMS
1770 NEXT I
1780 RETURN
1800PRINT\PRINT\PRINT"STUDY THAT, THEN PRESS 'RETURN'."\INPUT$Z\RETURN
3000FORJ=0TOS
3010PRINTCHR$(P(J));
3020NEXTJ                             PRINT FIRST NAME OF STUDENT
3030RETURN
4000END

READY
```

DEFINITION OF VARIABLES:

P, M, S - used in setting up student's name

B - the number of questions asked so far

R(1)-R(14) - the random values generated for use in the problems

Z - the student's response to the current question

K - the correct answer

MODIFICATION NOTES:

1. TO LIMIT THE PROGRAM TO ONE RUN THROUGH THE FIVE QUESTIONS

   - Delete statements 1261 and 1265
     (the score will be printed after all five questions have been answered correctly once, regardless of the number of errors.)

2. TO BYPASS THE MATH HELP SUBROUTINE

   - Change statement 800 to read:
     800 RETURN

III: ELECTRON

DESCRIPTION

The questions in this exercise provide drill in identifying the number of electrons having principal quantum numbers 1, 2, 3, or 4 in elements with atomic numbers from 1 - 22.

DISCUSSION

QUESTION FORMAT: This exercise poses one basic question of the form,

> HOW MANY K ELECTRONS IN AN ATOM WITH 17 PROTONS?

The letter designating the shell, or principal quantum number varies at random among K,L,M and N and the number of protons is varied randomly from 1 - 22. If the student responds incorrectly, the same question is restated in this form:

> THE ATOMIC NUMBER IS 17 AND WE'RE ASKING HOW MANY
> ELECTRONS IN ENERGY LEVEL 1?

If the second response is incorrect, the right answer is given followed by another question. A concise explanation of the principles involved is given if a student makes as many as three errors.

SCORING: The score is printed after every ten questions, and the student has the option to stop or continue. If the student decides to continue, his score is cumulative.

The score is computed as follows:

$$\frac{C - X}{C} \times 100\%$$

where C = total number of questions
X = number of incorrect responses times .5

PREPARATION

BACKGROUND: Students should understand how to write electron arrangements according to energy levels. For example: (2 - 8 - 8 - 1) for potassium atomic number 19.

TIME REQUIREMENTS: Approximately 20 minutes/student

DOCUMENTATION

SAMPLE RUN:

```
RUN

ELECTR   CANTERBURY


PLEASE TYPE YOUR FULL NAME.

TAGHI GHARAGOZLOU


THIS EXERCISE DEALS WITH THE NUMBER OF ELECTRONS IN EACH OF
THE FIRST FOUR ENERGY LEVELS.  NOTE THAT ELECTRONS IN THE
FIRST ENERGY LEVEL ARE REFERRED TO AS 'K' ELECTRONS, THOSE IN
THE 2ND ARE CALLED 'L', THOSE IN THE 3RD - 'M', AND ELECTRONS
IN THE 4TH ENERGY LEVEL ARE CALLED 'N' ELECTRONS.


 1 .  HOW MANY K ELECTRONS IN AN ATOM WITH  8  PROTONS?4


NO -

    TRY AGAIN - THE ATOMIC NUMBER IS  8
AND WE'RE ASKING HOW MANY ELECTRONS IN ENERGY LEVEL  1 ?6


NO -

THE ANSWER IS  2 .


 2 .  HOW MANY M ELECTRONS IN AN ATOM WITH  8  PROTONS?8


NO -

    TRY AGAIN - THE ATOMIC NUMBER IS  8
AND WE'RE ASKING HOW MANY ELECTRONS IN ENERGY LEVEL  3 ?0

RIGHT!!
YOU'VE MADE  3  MISTAKES SO FAR - IF YOU'D LIKE A LITTLE
HELP, TYPE Y; IF NOT TYPE N
Y
OKAY.  THE FIRST ENERGY LEVEL (K) CAN HAVE EITHER 1 OR 2
ELECTRONS - NO MORE!.   THE NEXT 8 GO INTO THE 2ND LEVEL (L).
THUS ABOVE ATOMIC NUMBER 10, YOU FIND ELECTRONS IN THE 3RD (M)
LEVEL, AND IT WILL ALSO TAKE UP TO 8 BEFORE ANY SHOW UP IN THE
4TH (N) LEVEL.  THAT MEANS THAT THE 4TH LEVEL STARTS FILLING AT
ATOMIC NUMBER WHAT?19


SO THAT MEANS THAT THE ELECTRON ARRANGEMENT IN
CALCIUM, ATOMIC NUMBER 20, IS 2-8-8-2.
```

```
STUDY THAT MUCH, THEN PRESS 'RETURN'.

BETWEEN ATOMIC NUMBERS 21-30 THINGS GET A BIT COMPLICATED,
WITH MORE ELECTRONS SHOWING UP IN THE 3RD LEVEL.  VANADIUM,
FOR EXAMPLE, ATOMIC #23, HAS ITS ELECTRONS ARRANGED 2-8-11-2.
SO IN OTHER WORDS, THE 3RD (M) LEVEL CAN HOLD 8, UNLESS THERE
ARE ELECTRONS IN THE 4TH (N) LEVEL, IN WHICH CASE IT CAN GO UP
AS HIGH AS 18.


OKAY, IF YOU ARE READY TO GO, PRESS 'RETURN'.


 3 .  HOW MANY L ELECTRONS IN AN ATOM WITH  7  PROTONS?5

RIGHT!!


 4 .  HOW MANY L ELECTRONS IN AN ATOM WITH  12  PROTONS?8

RIGHT!!


 5 .  HOW MANY M ELECTRONS IN AN ATOM WITH  13  PROTONS?3

CORRECT!!


 6 .  HOW MANY M ELECTRONS IN AN ATOM WITH  4  PROTONS?0

CORRECT!!


 7 .  HOW MANY M ELECTRONS IN AN ATOM WITH  2  PROTONS?0

RIGHT!!


 8 .  HOW MANY L ELECTRONS IN AN ATOM WITH  14  PROTONS?8

RIGHT!!


 9 .  HOW MANY L ELECTRONS IN AN ATOM WITH  7  PROTONS?5

RIGHT!!


 10 .  HOW MANY L ELECTRONS IN AN ATOM WITH  17  PROTONS?8

RIGHT!!


OKAY,TAGHI YOUR SCORE IS NOW  85 %.

MORE QUESTIONS?(Y OR N)
N
READY
```

PROGRAM LISTING:

```
5GOSUB1500
6PRINT\PRINT
10PRINT"THIS EXERCISE DEALS WITH THE NUMBER OF ELECTRONS IN EACH OF"
11PRINT"THE FIRST FOUR ENERGY LEVELS.  NOTE THAT ELECTRONS IN THE"
12PRINT"FIRST ENERGY LEVEL ARE REFERRED TO AS 'K' ELECTRONS, THOSE IN"
13PRINT"THE 2ND ARE CALLED 'L', THOSE IN THE 3RD - 'M', AND ELECTRONS"
14PRINT"IN THE 4TH ENERGY LEVEL ARE CALLED 'N' ELECTRONS."
16RANDOMIZE
19PRINT
20Y=0
21IFX>1THEN650   OFFER HINTS IF STUDENT HAS MADE 3 ERRORS
22PRINT
30C=C+1\IFC=1THEN32                  } INCREMENT QUESTION COUNTER, SEE IF
31IF(C-1)/10=INT((C-1)/10)THEN670   } 10, 20, 30...HAVE BEEN ASKED
32R=INT(4*RND(1)+75) PICK PRINCIPAL QUANTUM NO.
33PRINT
34Q=INT(22*RND(1))+1  PICK ATOMIC NO.
38IF R=75 THEN750  }
39IF R=76 THEN 800 } BRANCH TO PROPER SECTION TO COMPUTE ANSWER
40IF R=77 THEN850  }
41IF R=78 THEN900  }
50PRINTC".  HOW MANY "CHR$(R)" ELECTRONS IN AN ATOM WITH "Q" PROTONS";
51INPUTZ        }
53PRINT         } ACCEPT AND EVALUATE STUDENT'S ANSWER
60IFZ=KTHEN200  }
65GOSUB700      }
70IFY=2THEN150
72Y=1
80PRINT"     TRY AGAIN - THE ATOMIC NUMBER IS "Q
81PRINT"AND WE'RE ASKING HOW MANY ELECTRONS IN ENERGY LEVEL "R-74;
90GOTO51
150IFK=0THEN160   } SELECT APPROPRIATE COMMENT FOR INCORRECT RESPONSE
151IFK=8THEN170   }
153PRINT"THE ANSWER IS "K"."\GOTO20
160PRINT"THE ANSWER IS 0 - THERE ARE NO ELECTRONS IN THE "CHR$(R)" SHELL
161GOTO20
170PRINT"THE ANSWER IS 8, SINCE THE "CHR$(R)" SHELL IS FULL IN THIS CASE
171GOTO20
200FOR I=1 TO 7                           }
201 PRINT CHR$(135);                      }
202NEXT I                                 } RING BELL AND ACKNOWLEDGE
203IFRND(1)>.5THEN210\PRINT"CORRECT!!"    } RIGHT ANSWER
204 GOTO20                                }
210PRINT"RIGHT!!"\GOTO20                  }
650H1=H1+1
651IFH1>1THEN22                                               }
652PRINT"YOU'VE MADE "2*X" MISTAKES SO FAR - IF YOU'D LIKE A LITTLE"
653PRINT"HELP, TYPE Y; IF NOT TYPE N"                        }
654INPUT$Z                                                    } OFFER HELP, UNLESS IT'S BEEN
655IFZ=89THEN950                                              }  GIVEN BEFORE
656GOTO22                                                     }
670PRINT
671PRINT"OKAY,";                                              }
672GOSUB3000                                                  }
673PRINT"YOUR SCORE IS NOW "INT(((C-1-X)/(C-1)*100+.05)*10)/10"%."
675PRINT                                                      } COMPUTE SCORE
676PRINT"MORE QUESTIONS?(Y OR N)"                             }
677INPUT$Z                                                    }
```

```
678IFZ=89THEN32
680STOP
700X=X+.5
710Y=Y+1
720PRINT
725PRINT"NO - "                                  TALLY INCORRECT RESPONSE
730PRINT
740RETURN
750IF Q>1 THEN 754
751K=1
752GOTO50
754K=2
755GOTO50
800IF Q>2GOTO804
801K=0
802GOTO50
804IF Q>10 THEN808
805K=Q-2
806GOTO50
808K=8
809GOTO50
850IFQ>10 GOTO854
851K=0
852GOTO50                                        COMPUTE CORRECT ANSWER
854IF Q>18 GOTO860
855K=Q-10
856GOTO50
860IF Q>20 THEN 870
861K=8
862 GOTO50
870K=Q-12
871GOTO50
900IF Q>18 GOTO910
901K=0
902GOTO50
910IF Q>20GOTO920
911K=Q-18
912GOTO50
920K=2
921GOTO50
950PRINT
951PRINT"OKAY.  THE FIRST ENERGY LEVEL (K) CAN HAVE EITHER 1 OR 2"
952PRINT"ELECTRONS - NO MORE!.   THE NEXT 8 GO INTO THE 2ND LEVEL (L)."
953PRINT"THUS ABOVE ATOMIC NUMBER 10, YOU FIND ELECTRONS IN THE 3RD (M)"
954PRINT"LEVEL, AND IT WILL ALSO TAKE UP TO 8 BEFORE ANY SHOW UP IN THE"
955PRINT"4TH (N) LEVEL.  THAT MEANS THAT THE 4TH LEVEL STARTS FILLING AT
956PRINT"ATOMIC NUMBER WHAT";\INPUTZ
957IFZ=19THEN960\PRINT"NO, THE ANSWER IS 19.  THE 4TH LEVEL STARTS TO"
958PRINT"FILL WHEN THERE ARE 2 IN THE 1ST, 8 IN THE 2ND, & 8 IN THE 3RD"
960PRINT\PRINT\PRINT"SO THAT MEANS THAT THE ELECTRON ARRANGEMENT IN"
961PRINT"CALCIUM, ATOMIC NUMBER 20, IS 2-8-8-2."\PRINT\PRINT
962PRINT"STUDY THAT MUCH, THEN PRESS 'RETURN'."\INPUT$Z
963PRINT
965PRINT"BETWEEN ATOMIC NUMBERS 21-30 THINGS GET A BIT COMPLICATED, "
966PRINT"WITH MORE ELECTRONS SHOWING UP IN THE 3RD LEVEL.  VANADIUM,"
967PRINT"FOR EXAMPLE, ATOMIC #23, HAS ITS ELECTRONS ARRANGED 2-8-11-2."
968PRINT"SO IN OTHER WORDS, THE 3RD (M) LEVEL CAN HOLD 8, UNLESS THERE"
969PRINT"ARE ELECTRONS IN THE 4TH (N) LEVEL, IN WHICH CASE IT CAN GO UP"
970PRINT"AS HIGH AS 18."
971PRINT\PRINT\PRINT"OKAY, IF YOU ARE READY TO GO, PRESS 'RETURN'."
```

```
973INPUT$Z
974GOTO20
1500PRINT
1510DIMP(40)
1520PRINT"PLEASE TYPE YOUR FULL NAME."
1525PRINT                                        ACCEPT NAME
1527INPUT$P(M)
1530IFP(M)=32THEN1540
1535IFP(M)=13THEN1550
1536GOTO1541
1540P1=M
1541M=M+1
1545GOTO1527
1550PRINT
1560RETURN
3000FOR J=0TOP1
3010PRINTCHR$(P(J));                             PRINT FIRST NAME
3020NEXTJ
3030RETURN
4000END

READY
```

DEFINITION OF VARIABLES:

R - the principal quantum number +74, to yield the ASCII code for the letters K,L,M,N

C - the number of questions asked so far

Z - the student's response to any question

K - the correct answer

Y - error counter for current question

Q - the atomic number of the element in question

X - the point value of the errors (.5 times the number of mistakes)

P,M,P1 - used in setting up student's name

MODIFICATION NOTES:

1. TO MAKE SCORE CUMULATIVE ONLY FOR ONE 10-QUESTION SEQUENCE

   Change statements 20 and 678 as follows:

```
20 Y = 0\X = 0
678 IF Z = 89 THEN 20
```

2. TO CHANGE TERMINOLOGY FROM K,L,M,N SHELLS TO QUANTUM NUMBERS

- Delete statements 10-14
- Change the following statements to read:

```
 32 R=INT (4*RND(1) +1)
 38 IF R=1 THEN 750
 39 IF R=2 THEN 800
 40 IF R=3 THEN 850
 41 IF R=4 THEN 900
 50 PRINT C".  IN AN ATOM WITH "Q" PROTONS, HOW MANY ELECTRONS
    HAVE A"
 51 PRINT "PRINCIPAL QUANTUM NUMBER OF "R;
 52 INPUT Z
 81 PRINT "AND WE'RE ASKING HOW MANY ELECTRONS IN ENERGY
    LEVEL "R;
160 PRINT "THE ANSWER IS 0 - THERE ARE NO ELECTRONS IN LEVEL "R"."
170 PRINT "THE ANSWER IS 8, SINCE LEVEL "R" IS FULL IN THIS CASE."
```

IV: ATOM

DESCRIPTION

The student is given the atomic number and mass number of an element which lies between LITHIUM and TITANIUM on the periodic table. The sequence of questions asks him to describe the structure of this atom in terms of the number of protons, neutrons and electrons in various s and p orbitals.

DISCUSSION

QUESTION FORMAT: The atomic number of an element is selected at random from among the integers between 3 and 22. A logical mass number is also selected at random. The dialogue starts as follows:

```
     CONSIDER THE ATOM WHOSE ATOMIC NUMBER IS 15 AND
     WHOSE MASS NUMBER IS 31
```

Then the following questions are asked one at a time:

```
     (A) HOW MANY PROTONS DOES IT HAVE?

     (B) HOW MANY NEUTRONS?

     (C) 2S  ELECTRONS?

     (D) 3P ELECTRONS?

     (E) 2P ELECTRONS?

     (F) HOW MANY VALENCE (OUTER SHELL) ELECTRONS?
```

SCORING: When a question is answered correctly, the program proceeds to the next question in the sequence, until all the questions have been asked. Then the sequence starts again for a second atom.

If an answer is incorrect, a second trial is allowed but the error is tallied. If the second response is wrong an explanation of the correct answer is provided, and the sequence starts again from question (A) with a new atom.

The score is computed after question F has been answered and at least ten questions have been tried. A unique score is tabulated for each sequence of problems.

The score is formulated as follows:

$$\frac{Cl}{C} \times 100\%$$

where Cl = number of correct answers
C = total number of questions

PREPARATION

BACKGROUND: Once the class has covered atomic number, mass number, s and p orbitals, and the meaning of the term "outer shell" electrons, this exercise can be assigned. Students should be advised that:

(1) all atoms are in their ground state.

(2) 0 is a legitimate answer to the questions regarding the number of electrons in many cases (for example, 4p electrons in carbon)

MATERIALS: Periodic table (recommended)

TIME REQUIREMENT: Approximately 15-20 minutes/student

DOCUMENTATION

SAMPLE RUN:

```
RUN

ATOM    CANTERBURY

A     T     O     M     I     C         STRUCTURE
<><><><><><><><><><><><><><><><><><><><><><><><><><><><><><><>

PLEASE TYPE YOUR FULL NAME.

DEMOCRITUS
```

```
CONSIDER THE ATOM WHOSE ATOMIC NUMBER IS  12
AND WHOSE MASS NUMBER IS  26 .


HOW MANY PROTONS DOES IT HAVE?12
RIGHT!!


HOW MANY NEUTRONS?12
NO-TRY AGAIN.

HOW MANY NEUTRONS?26
NO - NEUTRONS + PROTONS = MASS NUMBER; IF THERE ARE  12  PROTONS,
THERE MUST BE  26  -  12 , OR  14  NEUTRONS.

                             .
STUDY THAT, THEN PRESS 'RETURN'

!
!
:
!
!

CONSIDER THE ATOM WHOSE ATOMIC NUMBER IS  9
AND WHOSE MASS NUMBER IS  21 .


HOW MANY PROTONS DOES IT HAVE?9
RIGHT!!


HOW MANY NEUTRONS?12
RIGHT!!


OKAY, HOW ABOUT THE NUMBER OF  3  S ELECTRONS?0
RIGHT!!

 4  P ELECTRONS?0
RIGHT!!

 2  S ELECTRONS?0
NO-TRY AGAIN.

 2  S ELECTRONS?7
THERE CAN ONLY BE 1 OR 2 'S' ELECTRONS PER EN. LEVEL
     HERE THERE ARE 2     2  S ELECTRONS


STUDY THAT, THEN PRESS 'RETURN'


!
!
:

CONSIDER THE ATOM WHOSE ATOMIC NUMBER IS  20
AND WHOSE MASS NUMBER IS  40 .


HOW MANY PROTONS DOES IT HAVE?20
RIGHT!!
```

```
HOW MANY NEUTRONS?20
RIGHT!!


OKAY, HOW ABOUT THE NUMBER OF  4  P ELECTRONS?0
RIGHT!!

 2  S ELECTRONS?2
RIGHT!!

 2  P ELECTRONS?6
RIGHT!!

HOW MANY VALENCE (OUTER SHELL) ELECTRONS?2
RIGHT!!

OUT OF  27  QUESTIONS, D YOUR SCORE IS  63 %.
WANT SOME MORE QUESTIONS (Y OR N)?N

READY
```

PROGRAM LISTING:

```
10 PRINT"A       T      O     M     I     C        STRUCTURE"
11PRINT"<><><><><><><><><><><><><><><><><><><><><><><><><><><>"
15GOSUB1500
16RANDOMIZE
20GOSUB 400
21REM ESTABLISH A,M,N,Q1,Q2,V
25PRINT
26PRINT
30PRINT"CONSIDER THE ATOM WHOSE ATOMIC NUMBER IS "A
31PRINT"AND WHOSE MASS NUMBER IS "M"."                PRELIMINARY SET-UP
32PRINT
33PRINT
40GOSUB500
50GOSUB600
100 T=0
101PRINT"HOW MANY PROTONS DOES IT HAVE";
102 C=C+1
105INPUT R
110IF R=A THEN 130
111IF T=1 THEN 120
112GOSUB 700
115GO TO 101                                          QUESTION A
120PRINT"NO- THE ATOMIC NO.= THE NUMBER OF PROTONS, SO "A" IS THE ANSWER
121GOSUB1000
125GOTO780
130GOSUB 750
135PRINT
140 T=0
```

```
141PRINT"HOW MANY NEUTRONS";
142C=C+1
145INPUT R
150IF R=N THEN 170
151 IF T=1 THEN 160
152 GOSUB 700
155 GOTO 141                                          QUESTION B
160PRINT"NO - NEUTRONS + PROTONS = MASS NUMBER; IF THERE ARE "A" PROTONS
161PRINT"THERE MUST BE "M" - "A", OR "N" NEUTRONS."
162GOSUB1000
165PRINT\GOTO20
170GOSUB 750
175PRINT
176PRINT"OKAY, HOW ABOUT THE NUMBER OF ";
179 FOR S1 =1 TO 3
180 T=0
181IF Q2=2 THEN 185
182PRINT Q1" S ELECTRONS";
183 GOTO190
185PRINT Q1" P ELECTRONS";
190INPUT R
191 C=C+1
192  IF R=E THEN 290
193 IF T=1 THEN 200
194GOSUB700
195GOTO 181                                            QUESTIONS C, D, E
200IF Q2=2 THEN 220
202PRINT"THERE CAN ONLY BE 1 OR 2 'S' ELECTRONS PER EN. LEVEL"
203 PRINT"      HERE THERE ARE" E" - "Q1" S ELECTRONS"
204GOSUB1000
210PRINT\GOTO20
220IF R>6 THEN 250
221 IF L>Q1 THEN 240
222 IF L<Q1 THEN 230
223 IF V>2 THEN 226
224PRINT"WITH ONLY"V"ELECTRONS IN THIS SHELL THERE ARE NO P ELECTRONS"
225GOSUB1000\GOTO780
226PRINT"WITH 2"Q1"S ELECTRONS THERE ARE "E"  "Q1" P ELECTRONS"
227GOSUB1000\GOTO780
230PRINT"THIS ATOM HAS NO ELECTRONS IN THE  "Q1" ENERGY LEVEL!!!!!"
232 PRINT
233PRINT\GOTO20
240PRINT"THE" Q1" ENERGY LEVEL IS FULL, SO IT CONTAINS 2 " Q1
242PRINT"S ELECTRONS AND 6 "Q1 " P ELECTRONS"
243GOSUB1000\GOTO780
250PRINT"NO - YOU NEVER HAVE MORE THAN 6 P ELECTRONS IN ONE LEVEL"
251PRINT"IN THIS CASE THERE ARE  "E" ELECTRONS"
252GOSUB1000
255GOTO780
290 GOSUB 750
291Q(S1)=Q1
295 GOSUB 800
296 GOSUB 445
297GOSUB 600
298 NEXT S1
300 T=0
301C=C+1
302PRINT"HOW MANY VALENCE (OUTER SHELL) ELECTRONS";
303INPUT R
305 IF R=V THEN 377
306 IF T=1 THEN 320
```

```
310 GOSUB 700
311PRINT"REMEMBER - THE ATOMIC NUMBER IS "A"."
312 GOTO301
320 IF L=4 THEN 360
321 IF L =3 THEN 350
322 IF L=2 THEN 340
323 PRINT"THIS ATOM HAS "V" ELECTRONS IN ITS OUTER SHELL"
325PRINT
326 GOTO380
340PRINT"TWO ELECTRONS IN THE K SHELL LEAVES "V" IN THE OUTER SHELL"
341GOSUB1000                                   QUESTION F
343GOTO380
350PRINT"TWO IN THE K, 8 IN THE L SHELL LEAVES "V" IN THE OUTERMOST"
351GOSUB1000
355GOTO380
360IF A>20 THEN 370
361PRINT"2 IN THE 'K', 8 IN THE 'L', 8 MORE IN THE 'M', LEAVES "V
362PRINT"FOR THE OUTERMOST SHELL"
365 GOTO 380
370PRINT"THIS IS A TRANSITION ELEMENT WITH 2 IN THE OUTSIDE LEVEL"
375PRINT
376GOTO380
377 GOSUB 750
380IFC<12THEN20
381K=K+1
385PRINT"OUT OF "C" QUESTIONS, ";
386GOSUB3000
387PRINT" YOUR SCORE IS "INT(((C1/C*100)+.05)*10)/10"%."
388PRINT"WANT SOME MORE QUESTIONS (Y OR N)?";
389INPUT$Z                                        COMPUTE, PRINT SCORE
390PRINT
391IFZ<>89THEN395
392X=0\C1=0\C=0
393GOTO20
395 STOP
400REM TO SELECT A,N,M, Q1 (PRIMARY QUANTUM NO. AND) Q2 (SEC)
405 A=INT(20*RND(1))+3   PRINCIPAL ATOMIC NO. BETWEEN 3-22
415 I=INT(6*RND(1))-2
420N=A+I                 COMPUTE MASS NUMBER
425M=A+N
430 Q2=INT(2*RND(1))+1   SEC. QUANTUM NO.
445Q1=INT(RND(1)*3)+Q2   PRINCIPAL Q. NO.
446IFQ1=Q(1)THEN445
450RETURN
500 REM TO DETERMINE V (VALENCE ELECTRONS)
501IF A>2 THEN 510
502L=1
503V=A
504GOTO550
510 IF A>10 GOTO520
512 L=2
514V=A-2
516GOTO550
520IFA>18 GOTO530          DETERMINE NUMBER OF ELECTRONS IN
522 L=3                    OUTERMOST OCCUPIED ENERGY LEVEL
524V=A-10
526GOTO 550
530L=4
532IFA=19 THEN 540
534 V=2
536 GOTO550
540V=1
550 RETURN
```

```
600 REM ELECTRON DETERMINATION
602 IF Q1>L THEN 680
604 IF Q1<L THEN 660
606 IF V>2 THEN 640
608 IF Q2>1 THEN 680
610 E=V
620 GOTO 690
640 IF Q2=1 THEN 650
641 E=V-2
645 GOTO 690
650 E=2
655GOTO 690
660 IF Q2=1 THEN 675
665E=6
667 GOTO690
670IF Q1=1 THEN 680
675 E=2
677 GOTO690
680 E=0
690 RETURN
```

DETERMINE ANSWERS TO QUESTIONS C, D, E

```
700REM WRONG ANSWER SUBROUTINE
701 T=1
702X=X+1
705IF RND(1)>.25THEN710
706PRINT"THAT'S WRONG,";
707GOSUB3000
708PRINT" THINK ABOUT IT. THEN TRY AGAIN."
709GOTO715
710PRINT"NO-TRY AGAIN."
711PRINT
715RETURN
```

FOR EACH WRONG ANSWER

```
750REM RIGHT ANSWER SUBROUTINE
751 FOR F=1 TO 7
752PRINT CHR$(135);
753 NEXT F
754PRINT"RIGHT!!"
755 PRINT
756C1=C1+1
760RETURN
```

FOR EACH RIGHT ANSWER

```
780GOTO20
800 IF Q2=1 THEN 803
801 Q2=1
802 GOTO804
803 Q2=2
804 RETURN
```

TO PREVENT DUPLICATION IN QUESTIONS C, D & D, E

```
1000PRINT\PRINT\PRINT"STUDY THAT, THEN PRESS 'RETURN'"\INPUT$Z\RETURN
1500PRINT
1510DIMP(40)
1520PRINT"PLEASE TYPE YOUR FULL NAME."
1525PRINT
1527INPUT$P(M)
1530IFP(M)=32THEN1540
1535IFP(M)=13THEN1550
1536GOTO1541
1540P1=M
1541M=M+1
1545GOTO1527
1550PRINT
1560RETURN
```

INPUT NAME

```
3000FOR J=0TOP1
3010PRINTCHR$(P(J));
3020NEXTJ
3030RETURN
4000END

READY
```

} PRINT FIRST NAME

DEFINITION OF VARIABLES:

A - the atomic number of the element in question

M - the mass number

N - the number of neutrons

I - used in computing the mass number (varies from -2 to 3)

Q1 - the primary quantum number (between 1-4) for questions concerning electrons

Q2 - the secondary quantum number (restricted to 1 or 2 for s,p)

V - the number of outer shell (valence) electrons

T - 0 unless the current question has been missed once

C - the number of questions asked so far

R - the student's response

S1 - counter for number of electron questions (varies 1 to 3)

E - the number of electrons to answer questions C-E

L - the period of the current element

F - used to ring the bell on teletype for correct answers

P,M,P1 - used in setting up student's name

MODIFICATION NOTES:

1. TO CHANGE THE NUMBER OF QUESTIONS
   - Change statement 380 (current number is 10)
2. TO CHANGE THE NUMBER OF QUESTIONS CONCERNING s, p ELECTRONS
   - Modify statement 179 (current number is 3)
3. TO ELIMINATE STARTING OVER AFTER EACH ERROR

STATEMENT NUMBER	MODIFICATION
125	GO TO 135
165	GO TO 175
210	(DELETE)
225	(DELETE)
243	(DELETE)
255	(DELETE)
227	GO TO 291
233	GO TO 291

V: PERIOD

DESCRIPTION

This exercise gives students practice in using the periodic table and applying the Periodic Law. The questions require an understanding of the relationships which exist between elements and their position in the periodic table.

DISCUSSION

QUESTION FORMAT: The chemical elements are selected at random from periods 2 - 6, excluding the transition and rare earth elements. The questions are of the following form:

(A) GIVE THE ATOMIC NUMBER OF AN ELEMENT WITH PROPERTIES LIKE ELEMENT # 11.

(B) IS THE IONIZATION ENERGY OF ELEMENT 16 GREATER OR LESS THAN THAT OF ELEMENT 34?

(C) GIVE THE ATOMIC NUMBER OF AN ELEMENT WITH THE SAME NUMBER OF OUTER SHELL ELECTRONS AS ELEMENT NUMBER 56.

(D) IS THE IONIZATION ENERGY OF ELEMENT 20 GREATER OR LESS THAN THAT OF ELEMENT # 19?

(E) WHAT IS THE MOST PROBABLE OXIDATION STATE FOR ELEMENT # 12?

The pair of elements in (B) are from the same group, those in (D) are from the same period, and the element in (E) is from Group I, II, IIIA, VIA, or VII.

An explanation is given each time a question is answered incorrectly; then the same question is asked again using a different element. The entire sequence (questions A to E) is presented twice before the score is given. A student who scores less than 85% on this exercise is considered unsuccessful and the sequence starts over.

SCORING: The score is computed as follows:

$$\frac{Q - X}{Q} \times 100\%$$

where Q = total number of questions asked
X = number of errors

PREPARATION

BACKGROUND: This exercise may be assigned as soon as class discussions have covered periodicity, ionization energy and the concept of oxidation state.

MATERIALS: Periodic table

TIME REQUIREMENT: Approximately 20 minutes/student

DOCUMENTATION

SAMPLE RUN:

```
RUN


PERIOD  CANTERBURY

USE A PERIODIC TABLE TO ANSWER THESE QUESTIONS


PLEASE TYPE YOUR FULL NAME.


ALEXANDER STARDUST


AN ELEMENT WITH PROPERTIES LIKE ELEMENT # 3  COULD HAVE
WHAT ATOMIC NUMBER?4


WRONG
TRY AGAIN-
AN ELEMENT WITH PROPERTIES LIKE ELEMENT # 3  COULD HAVE
WHAT ATOMIC NUMBER?8


NO-SIMILAR PROPERTIES MEANS SAME FAMILY, I.E. SAME COLUMN!


STUDY THAT, THEN PRESS 'RETURN'.

AN ELEMENT WITH PROPERTIES LIKE ELEMENT # 34  COULD HAVE
WHAT ATOMIC NUMBER?16


CORRECT
```

```
IS THE IONIZATION ENERGY OF ELEMENT # 8  GREATER OR
LESS THAN ELEMENT # 16 ?


ANSWER G OR L:L

WRONG
IONIZATION ENERGY DECREASES AS VALENCE ELECTRONS ARE
FURTHER AND FURTHER FROM THE NUCLEUS.


STUDY THAT, THEN PRESS 'RETURN'.

IS THE IONIZATION ENERGY OF ELEMENT # 85  GREATER OR
LESS THAN ELEMENT # 35 ?


ANSWER G OR L:L

RIGHT


AN ELEMENT WITH THE SAME NUMBER OF OUTER SHELL ELECTRONS AS
ELEMENT # 6  COULD HAVE WHAT ATOMIC NUMBER?10
WRONG
TRY AGAIN
AN ELEMENT WITH THE SAME NUMBER OF OUTER SHELL ELECTRONS AS
ELEMENT # 6  COULD HAVE WHAT ATOMIC NUMBER?8
NO,ALEXANDER IT HAS TO BE IN THE SAME COLUMN, LIKE #  82 .


STUDY THAT, THEN PRESS 'RETURN'.

AN ELEMENT WITH THE SAME NUMBER OF OUTER SHELL ELECTRONS AS
ELEMENT # 52  COULD HAVE WHAT ATOMIC NUMBER?34
RIGHT


IS THE IONIZATION ENERGY OF ELEMENT # 18  GREATER OR LESS
THAN ELEMENT # 13 ?


ANSWER G OR L:L


WRONG
ION. ENERGY GENERALLY INCREASES AS YOU MOVE TO THE RIGHT.


STUDY THAT, THEN PRESS 'RETURN'.

IS THE IONIZATION ENERGY OF ELEMENT # 82  GREATER OR LESS
THAN ELEMENT # 83 ?


ANSWER G OR L:L
```

```
RIGHT


WHAT IS THE MOST LIKELY OXIDATION STATE FOR ELEMENT # 8 ?2
I'M AFRAID NOT.
-2  IS THE ANSWER, SINCE IT FILLS AN OCTET WITH  2  ELECTRONS.


STUDY THAT, THEN PRESS 'RETURN'.

WHAT IS THE MOST LIKELY OXIDATION STATE FOR ELEMENT # 37 ?1
RIGHT


 7 ERRORS OUT OF 10 ISN'T TOO GOOD,ALEXANDER , SO  TRY SOME MORE.

 I
 I
 I

 91 % IS A PRETTY GOOD SCORE,ALEXANDER ; WANT MORE?(Y OR N)N
```

PROGRAM LISTING:

```
5DIMP(40)\RANDOMIZE
15PRINT"USE A PERIODIC TABLE TO ANSWER THESE QUESTIONS"
20PRINT
21PRINT
25PRINT"PLEASE TYPE YOUR FULL NAME."\PRINT\PRINT
26PRINT
27INPUT $P(I)                                INITIAL SETUP, ACCEPT
30 IF P(I)=32 THEN 40                        STUDENT'S NAME
35 IF P(I)=13 THEN 50
36 GOTO41
40P1=I
41I=I+1
45GOTO27
50PRINT\PRINT\PRINT
102 DIM A(5,8)
105 W=2
110 FOR I=1 TO 2
115 FOR J=1 TO 8
120 W=W+1
125 A(I,J)=W
130 NEXT J
140 NEXT I                                   ESTABLISH PERIODIC ARRANGE-
150 FOR I=3 TO 5                             MENT OF ATOMIC NUMBERS
155 FOR J= 1 TO 2
157 A(I,J)=(I-2)*18+J
160 NEXT J
162 NEXT I
165 FOR I=3 TO 5
167 FOR J= 3 TO 8
170 A(I,J)=(I-2)*18+10*(INT(I/5)+1)+4*(INT(I/5))+J
172 NEXT J
175 NEXT I
```

```
180 X=0
181 Q=0
182 C=0                                     RESET FOR STARTING OVER
200 F=0
205GOSUB1870
210 Q=Q+1
220PRINT"AN ELEMENT WITH PROPERTIES LIKE ELEMENT #"A(I,J)" COULD HAVE"
221PRINT"WHAT ATOMIC NUMBER";\INPUTZ
222PRINT\PRINT
235 FOR L=1 TO 5
236IF L=I THEN 245
240 IF Z=A(L,J) THEN 280                    QUESTION A
245 NEXT L
250 IF F=1 THEN 260
251 GOSUB 2700
255PRINT"TRY AGAIN-"
256GOTO220
260 X=X+1
265PRINT"NO-SIMILAR PROPERTIES MEANS SAME FAMILY, I.E. SAME COLUMN!"
266GOSUB1900
270GOTO205
280GOSUB2750
285PRINT
286PRINT
300GOSUB 1600
310 Q=Q+1
320PRINT"IS THE IONIZATION ENERGY OF ELEMENT #"A(I1,J1)" GREATER OR"
321PRINT"LESS THAN ELEMENT #"A(I2,J1)"?"\PRINT\PRINT
330GOSUB1820
332 IF I2>I1 THEN 336
333 K=#L
334 GOTO 338
336 K=#G
338 GOSUB 1800
340 IF Z=K THEN 380                           QUESTION B
350 GOSUB 2700
365PRINT"IONIZATION ENERGY DECREASES AS VALENCE ELECTRONS ARE "
366PRINT"FURTHER AND FURTHER FROM THE NUCLEUS."
367GOSUB1900
370GOTO300
375PRINT
376PRINT
380GOSUB2750
385PRINT
386PRINT
400 F=0
405GOSUB1500
410Q=Q+1
420PRINT"AN ELEMENT WITH THE SAME NUMBER OF OUTER SHELL ELECTRONS AS"
421PRINT"ELEMENT #"A(I,J)" COULD HAVE WHAT ATOMIC NUMBER";\INPUTZ
435FOR L=1 TO 5
436IF L=I THEN 445
437L1=L
440 IF Z=A(L,J) THEN 480                      QUESTION C
445 NEXT L
450 IF F=1 THEN 460
451GOSUB2700
455PRINT"TRY AGAIN"
456GOTO420
460X=X+1
465PRINT"NO,";
466GOSUB3000
```

```
467PRINT"IT HAS TO BE IN THE SAME COLUMN, LIKE # "A(L1,J)"."
468GOSUB1900
470GO TO 405
480GOSUB2750
485PRINT
486PRINT
500GOSUB1700
510Q=Q+1
520PRINT"IS THE IONIZATION ENERGY OF ELEMENT #"A(I1,J1)" GREATER OR LESS
521PRINT"THAN ELEMENT #"A(I1,J2)"?"\PRINT\PRINT
530GOSUB1820
531IF J1>J2 THEN 536
532K=#L
534GOTO538
536K=#G
538GOSUB1800                        QUESTION D
539PRINT
540 IF Z=K THEN 580
550GOSUB 2700
565PRINT"ION. ENERGY GENERALLY INCREASES AS YOU MOVE TO THE RIGHT."
566GOSUB1900
570GO TO 500
575PRINT
576PRINT
580 GOSUB 2750
585PRINT
586PRINT
600I=INT(RND(1)*5+1)
602J=INT(7*RND(1)+1)
603IFJ=4THEN 602
604IF J=5THEN602
610PRINT"WHAT IS THE MOST LIKELY OXIDATION STATE FOR ELEMENT #"A(I,J);
615Q=Q+1
626INPUT Z
630 IF J>4 THEN 633
631K=J
632GOTO640                          QUESTION E
633K=J-8
640IF Z=K THEN 660
642GOSUB 2700
644IF K<0 THEN 648
645PRINT"NO-SINCE IT TENDS TO LOSE "K" ELECTRONS, THE ANSWER IS +"K"."
646GOTO650
648PRINTK" IS THE ANSWER, SINCE IT FILLS AN OCTET WITH "-K" ELECTRONS."
650GOSUB1900\GOTO600
660GOSUB2750
680GOTO0900
900PRINT
910PRINT
915IF Q<10 THEN 200   RESTART IF LESS THAN 10 QUESTIONS ASKED
920IFC/Q<.85 THEN 950
925PRINTINT((Q-X)/Q*100+.5)"% IS A PRETTY GOOD SCORE,";
926GOSUB3000
930PRINT"; WANT MORE?(Y OR N)";
934INPUT $Z
936 IF Z=89 THEN 200         CHECK SCORE, GIVE OPTION TO START OVER,
941PRINT                     OR RESTART, AS APPROPRIATE
942STOP
950PRINTX"ERRORS OUT OF"Q"ISN'T TOO GOOD,";
```

```
951GOSUB3000
952PRINT", SO  TRY SOME MORE."
953PRINT
954PRINT
955GOTO180
1500I=INT(RND(1)*5+1)             PICK AN ELEMENT FOR QUESTION C
1520J=INT(8*RND(1))+1
1530 RETURN
1600I1=INT(RND(1)*5+1)            PICK TWO ELEMENTS FOR QUESTION B,
1620I2=INT(5*RND(1)+1)            SAME COLUMN, DIFFERENT ROWS
1630IF I2=I1 THEN 1620
1640J1=INT(8*RND(1)+1)
1650RETURN
1700I1=INT(RND(1)*5+1)
1720J1=INT(8*RND(1)+1)
1730 IF J1=2 THEN 1720            PICK TWO ELEMENTS FOR QUESTION D,
1740 IF J1=6 THEN 1720            SAME ROW, DIFFERENT COLUMNS
1750 J2=INT(8*RND(1)+1)           (EXCLUDING COLUMNS II AND VI)
1760 IF J2=J1 THEN 1750
1770 IF J2=6 THEN 1750
1780 IF J2=2 THEN 1750
1790 RETURN
1800 IF Z=#G THEN 1850                   RESPONSE TO QUESTIONS B AND D
1810 IF Z=#L THEN 1850
1820PRINT"ANSWER G OR L:";\INPUT$Z
1830PRINT\PRINT
1850RETURN
1870 I=INT(5*RND(1)+1)            PICK AN ELEMENT FOR QUESTION A
1875J=INT(7*RND(1)+1)
1890 RETURN
1900PRINT\PRINT\PRINT"STUDY THAT, THEN PRESS 'RETURN'.";\INPUT$Z
1910PRINT\PRINT\RETURN
2700 X=X+1
2710 IF RND(1)>.5 THEN  2720
2712 PRINT "WRONG"                 TALLY INCORRECT A
2715 GOTO 2730
2720PRINT"I'M AFRAID NOT."
2730 F=1
2740 RETURN
2750 FOR W=1 TO 5
2755 PRINT CHR$(135);
2760 NEXT W
2765 C=C+1                         RING BELL, ACKNOWLEDGE CORRECT ANSWER
2770 IF RND(1)>.5 THEN 2780
2775 PRINT"CORRECT"
2776 GOTO 2790
2780 PRINT"RIGHT"
2790 RETURN
3000FORV=0TOP1                      PRINT FIRST NAME
3010PRINT CHR$(P(V));
3020NEXTV
3030RETURN
4000 END

READY
```

DEFINITION OF VARIABLES:

P,I,P1 - used in setting up student's name

A(I,J) - the atomic number of an element in the Ith period and the Jth group

W - used in establishing the data bank of atomic numbers

X - the number of errors

Q - the number of questions asked

C - the number of correct responses

Z - the student's response

K - the correct answer to the current question

L - used in scanning a column to check answer in questions A and C

F - 0 unless question A or C has been missed on the first try

MODIFICATION NOTES:

1. TO CHANGE THE MINIMUM SATISFACTORY SCORE
   - Modify statement 920 (currently 85%)
2. TO CHANGE THE NUMBER OF QUESTIONS IN A SEQUENCE
   - Change statement 915 (currently a minimum of 10)

VI: COMPOSITION

DESCRIPTION

This exercise gives practice in working with quantitative relationships between the elements that compose simple binary compounds. A compound is selected at random from 42 possible combinations of six anions and seven cations. Four questions are asked about the compound, concerning percent composition and relative number of grams and moles which combine to form it.

DISCUSSION

QUESTION FORMAT: A compound is selected from combinations of the following:

CATIONS: SILVER, SODIUM, POTASSIUM, BARIUM, MAGNESIUM, CALCIUM, ALUMINUM

ANIONS: CHLORIDE, BROMIDE, IODIDE, SULFIDE, SELENIDE, OXIDE

The sequence of questions begins in this manner:

CONSIDER THE COMPOUND FORMED BETWEEN SILVER AND OXYGEN

The elements vary each time the program is run. The four questions to be answered are:

(1) WHAT PERCENT IS SILVER?
(2) HOW MANY MOLES OF OXYGEN ATOMS COMBINE WITH *** MOLES OF SILVER ATOMS TO FORM IT?
(3) HOW MANY GRAMS OF OXYGEN COMBINE WITH *** MOLES OF SILVER?
(4) HOW MANY GRAMS OF OXYGEN COMBINE WITH *** GRAMS OF SILVER?

The ions chosen provide five different types of compounds:

AB A_2B AB_2 A_2B_3 and AB_3

The values inserted at the *** vary within logical limits. When a question is answered incorrectly (more than 2 percent deviation from the correct answer) an explanation is given with the solution, and the program continues to the next question. If a student misses more than two questions during the exercise, he starts again.

SCORING: The score is computed as follows:

$$\frac{12 - X}{12} \times 100\%$$

where X is the number of incorrect answers.

PREPARATION

BACKGROUND: This exercise is appropriate for students who have been introduced to the term 'mole' and formula writing.

Since students often want to do the problems without writing the formula, the recommendation is made in each sequence to write the formula first; it is up to the teacher's discretion to insist on this practice.

MATERIALS: Table of atomic weights
List of common oxidation states

TIME REQUIREMENT: Approximately 30-45 minutes/student

DOCUMENTATION

SAMPLE RUN:

```
COMPOS  CANTERBURY

PLEASE TYPE YOUR FULL NAME.

BILL ANDREWS

CONSIDER THE COMPOUND FORMED BY ALUMINUM AND IODINE.


WHAT PERCENT IS ALUMINUM?
(HINT: WRITE THE FORMULA DOWN FIRST!!)


NEED MATH HELP (Y OR N)?Y
MULTIPLICATION OR DIVISION(M OR D)?D
DIVISOR=?408
DIVIDEND=?27
 27 / 408 = 6.61765E-2
MORE HELP?

N
ANSWER=?6.6
RIGHT!!
```

```
HOW MANY MOLES OF ALUMINUM COMBINE WITH
 10  MOLES OF IODINE ATOMS TO FORM IT?3.3
OKAY!!

HOW MANY GRAMS OF ALUMINUM COMBINE WITH   .5  MOLES OF IODINE ATOMS


NEED MATH HELP (Y OR N)?Y
MULTIPLICATION OR DIVISION(M OR D)?M
FIRST NUMBER=?.16667
2ND NO.=?27
 .16667 X 27 = 4.50009
MORE HELP?

N
ANSWER=?4.5
RIGHT!!

HOW MANY GRAMS OF ALUMINUM COMBINE WITH  465  GRAMS OF IODINE?


NEED MATH HELP (Y OR N)?Y
MULTIPLICATION OR DIVISION(M OR D)?D
DIVISOR=?127
DIVIDEND=?408
 408 / 127 = 3.2126
MORE HELP?

Y
MULTIPLICATION OR DIVISION(M OR D)?M
FIRST NUMBER=?27
2ND NO.=?3.2
 27 X 3.2 = 86.4
MORE HELP?

N
ANSWER=?86.4
NO-
 465 GMS OF IODINE IS  465 / 127  OR  3.66142  MOLES, SO YOU NEED
 1 / 3  TIMES  3.66142  MOLES OF ALUMINUM.  THIS EQUALS
 1.22047  TIMES  27  GRAMS, OR  32.9527 GMS.


STUDY THAT, THEN HIT 'RETURN'



CONSIDER THE COMPOUND FORMED BY BARIUM AND CHLORINE.


WHAT PERCENT IS BARIUM?
(HINT: WRITE THE FORMULA DOWN FIRST!!)


NEED MATH HELP (Y OR N)?N
ANSWER=?65
OKAY!!
```

PROGRAM LISTING:

```
10DIMP(40)
15RANDOMIZE
20PRINT"PLEASE TYPE YOUR FULL NAME."
25PRINT
27INPUT$P(M)
30IF P(M)=32 THEN 40                      INPUT NAME
35IF P(M)=13 THEN 50
36GOTO41
40P1=M
41M=M+1
45GOTO27
50PRINT
100C(1)=23
110C(2)=39.1
115C(3)=107.9
120C(4)=24.3
125C(5)=40.1
130C(6)=137.3
135C(7)=27                                 SET UP LIST OF ATOMIC WEIGHTS
140A(1)=35.5
145A(2)=79.9
150A(3)=127
155A(4)=16
160A(5)=32
165A(6)=79
200GOTO2010
500I=INT(RND(1)*7+1)     CHOOSE CATION (I) AND ANION (J)
520J=INT(RND(1)*6+1)
530L=INT(RND(1)*8+2)/10     CHOOSE NUMBERS FOR QUESTIONS 3 & 4
540N=INT(RND(1)*500+100)
550RETURN
600PRINT
601PRINT
602PRINT"STUDY THAT, THEN HIT 'RETURN'"     PAUSE AFTER EXPLANATION
603INPUT$Z\PRINT\PRINT
604RETURN
700X1=X1+1          AFTER EACH WRONG ANSWER
710PRINT"NO-"
720RETURN
750IF RND(1)>.5 THEN 757
755PRINT"RIGHT!!"          AFTER EACH RIGHT ANSWER
756GOTO770
757PRINT"OKAY!!"
770RETURN
800PRINT"NEED MATH HELP (Y OR N)?";
805INPUT $Z
810PRINT
815 IF Z=89 THEN 825
816 IF Z=#N THEN 925
820PRINT"PLEASE ANSWER Y OR N";
821 GOTO 805
825PRINT"MULTIPLICATION OR DIVISION(M OR D)?";
830 INPUT $Z
831PRINT
835IF Z=77 THEN 875
837IF Z<>#D THEN 825                       MATH SUBROUTINE
840PRINT"DIVISOR=";
845INPUT D1
850PRINT"DIVIDEND=";
```

```
855INPUT D2
860PRINT D2"/"D1"="D2/D1
865PRINT"MORE HELP?"
866PRINT
870GOTO805
875PRINT"FIRST NUMBER=";
876INPUT W
880PRINT"2ND NO.=";
881INPUT W1
885P=W*W1
890PRINT W"X"W1"="W*W1
895GOTO865
925RETURN
```

```
1110IF I=1THEN1510
1111IF I=2 THEN1520
1113IF I=3 THEN 1530
1114IF I=4 THEN 1540
1115 IF I=5 THEN 1550
1116 IF I=6 THEN 1560
1117 IF I=7 THEN 1570
```

CONTROL PRINTOUT OF CATION

```
1120RETURN
1130 IF J=1 THEN 1610
1132IF J=2 THEN 1620
1133 IF J=3 THEN 1630
1134 IF J=4 THEN 1640
1135 IF J=5 THEN 1650
1136 IF J=6 THEN 1660
```

CONTROL PRINTOUT OF ANION

```
1140 RETURN
1510PRINT"SODIUM";
1511GOTO1120
1520PRINT"POTASSIUM";
1521GOTO1120
1530PRINT"SILVER";
1531GOTO1120
1540PRINT"MAGNESIUM";
1541GOTO1120
1550PRINT"CALCIUM";
1551GOTO1120
1560PRINT"BARIUM";
1561GOTO1120
1570PRINT"ALUMINUM";
1571GOTO1120
1610PRINT"CHLORINE";
1611GOTO1140
1620PRINT"BROMINE";
1621GOTO1140
1630PRINT"IODINE";
1631GOTO1140
1640PRINT"OXYGEN";
1641GOTO1140
1650PRINT"SULFUR";
1651GOTO1140
1660PRINT"SELENIUM";
```

LIST OF IONS FOR COMPOUNDS

```
1661GOTO1140
2010GOSUB 500
2020IF I<4 THEN 2050
2025 IF I<7 THEN 2040
2026 IF J<4 THEN 2850
2027GOTO2900
2040IF J<4 THEN 2800
2041 GOTO2700
2050 IF J<4 THEN 2700
```

IDENTIFY TYPE OF COMPOUND

```
2051GOTO2750
```

COMPUTE CORRECT ANSWERS

```
2060PRINT
2065C=X*C(I)
2066T=X*C(I)+Y*A(J)
2067K1=C/T*100
2070K2=X/Y*(I+J)
2071K3=L*X/Y*C(I)
2074 K4=N/A(J)*X/Y*C(I)
2100Q=Q+1
```

FIRST QUESTION

```
2105PRINT"CONSIDER THE COMPOUND FORMED BY ";
2110GOSUB1110
2120PRINT" AND ";\GOSUB1130\PRINT"."
2140PRINT
2145PRINT
2200PRINT"WHAT PERCENT IS ";\GOSUB1110\PRINT"?"
2210PRINT"(HINT: WRITE THE FORMULA DOWN FIRST!!)"
2225PRINT
2226PRINT
2230GOSUB800
2240PRINT"ANSWER=";
2245INPUT Z
2250 IF ABS(Z-K1)<.02*K1 THEN 2290
2255GOSUB700
2260PRINT"DIVIDE THE MASS OF ";\GOSUB1110\PRINT" IN THE COMPOUND, "C
2270PRINT"BY THE FORMULA WEIGHT, "T" TO GET "K1/100
2271PRINT"WHICH IS"K1"PERCENT"
2272GOSUB600
2285GOTO2300
2290GOSUB750
2295PRINT
```

SECOND QUESTION

```
2300PRINT"HOW MANY MOLES OF ";\GOSUB1110\PRINT" COMBINE WITH"
2320PRINTI+J" MOLES OF ";
2325GOSUB1130
2330PRINT" ATOMS TO FORM IT";
2335INPUT Z
2340IF ABS(Z-K2)<.02*K2 THEN 2390
2345GOSUB700
2350PRINT"THE RATIO OF ATOMS OF ";
2351GOSUB1110
2352PRINT" TO ATOMS OF ";
2353GOSUB1130
2354PRINT" IS "X" TO"Y
2356PRINT"SO THE ANSWER IS "K2
2358GOSUB600
2360GOTO2400
2390GOSUB750
2395PRINT
```

THIRD QUESTION

```
2400PRINT"HOW MANY GRAMS OF ";
2410GOSUB1110
2415PRINT" COMBINE WITH "L" MOLES OF ";
2420GOSUB 1130
2425PRINT" ATOMS"
2426PRINT
2427PRINT
2430GOSUB800
2440PRINT"ANSWER=";
2445INPUTZ
2450 IF ABS(Z-K3)<.02*K3 THEN 2490
2455GOSUB700
2460PRINT"SINCE THE ATOM RATIO IS "X" TO "Y "YOU NEED "X/Y" TIMES"L
```

```
2461PRINT"MOLES OF ";
2462GOSUB1110
2463PRINT" OR "X/Y*L" TIMES "C(I)" GRAMS, OR"K3
2465GOSUB600
2470GOTO2500
2490GOSUB750
2495PRINT
2500PRINT"HOW MANY GRAMS OF ";
2505GOSUB1110
2510PRINT" COMBINE WITH "N " GRAMS OF ";
2515GOSUB1130
2520PRINT"?"
2525PRINT
2526PRINT
2530GOSUB 800
2540PRINT"ANSWER=";
2545INPUT Z                                        FOURTH QUESTION
2550 IF  ABS(Z-K4)<.02*K4 THEN 2590
2555 GOSUB 700
2560PRINTN"GMS OF ";
2565GOSUB1130
2568PRINT" IS "N"/"A(J)" OR "N/A(J)" MOLES, SO YOU NEED"
2569PRINTX"/"Y" TIMES "N/A(J)" MOLES OF ";
2570GOSUB1110\PRINT".  THIS EQUALS"
2571PRINTX/Y*(N/A(J))" TIMES "C(I)" GRAMS, OR "K4 "GMS."
2575GOSUB600
2580GOTO3500
2590GOSUB750
2595GOTO3500
2700X=1
2710Y=1
2720GOTO2060
2750X=2          ESTABLISH SUBSCRIPTS IN FORMULA, I.E. RATION
2760Y=1          OF CATION TO ANION
2770GOTO2060
2800X=1
2810Y=2
2820GOTO2060
2850X=1
2860Y=3
2870GOTO2060
2900X=2
2910Y=3
2920GOTO2060
3000 FOR J=0 TO P1
3010PRINT CHR$(P(J));          PRINT FIRST NAME
3020NEXT J
3030 RETURN
3500IF Q<3 THEN 2010
3505PRINTINT(((12-X1)/12*100)*10)/10"%";
3510 IF X1<3 THEN 3550
3515PRINT" ISN'T TOO GOOD,";
3516GOSUB3000
3520PRINT"TRY SOME MORE"                 COMPUTE AND PRINT SCORE
3525Q=0
3526X1=0
3530GOTO2010
3550PRINT " IS OKAY, ";
3555GOSUB3000
3570STOP
4000END
 READY
```

DEFINITION OF VARIABLES:

P, M, P1 - used in setting up student's name

C_i - the atomic weight of the ith cation

A_j - the atomic weight of the jth anion

I - the number of the cation in the current question

J - the number of the anion in the current question

I+J - the number of moles for Question 2

L - the number of moles for Question 3 (between .2 and .9)

N - the number of grams for question 4 (between 100 and 500)

X,Y - the subscripts in the formula for the compound

X1 - error counter

C - the weight of electropositive element in the compound

T - the formula weight of the compound

K1-K4 - the correct answers to the four questions

Q - the number of sets of 4 questions asked so far

Z - the student's response

MODIFICATION NOTES:

1. TO SUBSTITUTE DIFFERENT CATIONS OR ANIONS
   - Change the names in statements 1500 to 1600 and the corresponding atomic weights in statements 150 to 165.

     (Note that program logic requires the first three cations to have +1 oxidation numbers, the next three are +2, and the seventh is +3; similarly, the first three anions are -1 and the next three -2.)

2. TO CHANGE THE NUMBERS OF ERRORS THAT REQUIRE THE STUDENT TO START OVER
   - Modify statement 3510

VII: EQUATIONS

DESCRIPTION

This exercise deals with stoichiometry. Students are provided with six balanced equations and must answer a sequence of questions concerning quantitative relationships between substances in three of the reactions.

DISCUSSION

QUESTION FORMAT: Each question deals with quantities of grams, moles, or liters and is of the general form:

> HOW MUCH OF ONE SUBSTANCE IN THE REACTION IS PRODUCED BY (OR COMBINES WITH) A CERTAIN AMOUNT OF ANOTHER SUBSTANCE IN THE REACTION?

The six equations are:

	(A)		(B)		(C)		(D)
1.	$Al_2(SO_4)_3$	+	$3Ca(OH)_2$	=	$2Al(OH)_3$	+	$3CaSO_4$
2.	$2HCl$	+	FeS	=	H_2S	+	$FeCl_2$
3.	$AgNO_3$	+	$NaCl$	=	$NaNO_3$	+	$AgCl$
4.	$3C$	+	Fe_2O_3	=	$2Fe$	+	$3CO$
5.	$N_{2(g)}$	+	$3H_{2(g)}$	=	$2NH_{3(g)}$		
6.	$2C_4H_{10(g)}$	+	$13O_{2(g)}$	=	$8CO_{2(g)}$	+	$10H_2O_{(g)}$

Ten questions concerning three of the six equations are considered in each run of the program.

Questions 1-4	deal with one of the first four equations
Questions 5-8	deal with another of the first four equations
Questions 9-10	deal with one of the last two equations

(Refer to the SAMPLE RUN of this program for information regarding the question format.)

Before beginning this exercise, students are expected to have calculated the formula weights. To check that this has been done with reasonable care, the computer will first ask for three randomly selected formula weights before presenting Question 1. If any of the three is wrong, the program stops.

Students must answer all ten questions correctly before the score is given. If a question is answered incorrectly, it is followed by the correct answer, and an explanation; then the same question is repeated with different values.

NOTE: This program requires the NOLINE command on EduSystem 30.

SCORING: The score is computed as follows:

$$\frac{10}{C} \times 100\%$$

where C = total number of questions asked

PREPARATION

BACKGROUND: Assign this exercise as soon as students begin to work with equations in a quantitative manner. Remind them to calculate the formula weights before trying to run the program.

MATERIALS: List of equations and formula weights

TIME REQUIREMENT: Approximately 30 minutes/student

DOCUMENTATION

SAMPLE RUN:

```
READY
NOLINE

READY
RUN


EQUATI   CANTERBURY

PLEASE TYPE YOUR FULL NAME

ROBERT FINKELAFINSCH
LET'S CHECK YOUR FORMULA WEIGHTS FIRST,ROBERT
GIVE THE FORMULA WEIGHT FOR 'A' IN EQ. # 3 ?170
GIVE THE FORMULA WEIGHT FOR 'B' IN EQ. # 6 ?32
GIVE THE FORMULA WEIGHT FOR 'B' IN EQ. # 5 ?2


IN EQ. # 1 , HOW MANY  MOLES  OF SUBSTANCE 'A' REACT WITH  3
 MOLES  OF 'B'?


WANT MATH HELP (Y OR N)?N

ANS=?1

RIGHT!!

IN EQ. # 1 , HOW MANY  GRAMS  OF SUBSTANCE 'A' REACT WITH  2.5
 MOLES  OF 'B'?


WANT MATH HELP (Y OR N)?Y

MULTIPLICATION OR DIVISION (M OR D)?D
DIVISOR=?3
DIVIDEND=?2.5
 2.5 / 3 = .833334
MORE HELP?Y

MULTIPLICATION OR DIVISION (M OR D)?M
FIRST NUMBER=?342
2ND NO.=?.833
 342 X .833 = 284.886
MORE HELP?N

ANS=?284.9

RIGHT!!


IN EQ. # 1 , HOW MANY  MOLES  OF 'C' ARE FORMED FROM  1
 MOLES  OF 'A'?
```

```
WANT MATH HELP (Y OR N)?N

ANS=?2

RIGHT!!

IN EQ. # 1 , HOW MANY  GRAMS  OF 'C' ARE FORMED FROM  148
 GRAMS OF 'A'?

 |
 |
 |

ANS=?296

NO-

X: 148 = 156 GMS: 342 GMS,SO X=( 148 )( 156 )/ 342 , OR  67.5088


STUDY THAT, THEN HIT RETURN

IN EQ. # 1 , HOW MANY  GRAMS  OF 'C' ARE FORMED FROM  67
 GRAMS OF 'A'?

 |
 |
 |

IN EQ. # 3 , HOW MANY  MOLES  OF SUBSTANCE 'A' REACT WITH  97
 GRAMS  OF 'B'?

 |
 |
 |
 |

IN EQ. # 3 , HOW MANY  GRAMS  OF SUBSTANCE 'A' REACT WITH  74
 GRAMS  OF 'B'?

 |
 |
 |
 |
 |

IN EQ. # 3 , HOW MANY  MOLES  OF 'C' ARE FORMED FROM  2.2
 MOLES  OF 'A'?

 |
 |
 |
 |

OKAY,ROBERT  LET'S TAKE A DIFFERENT REACTION:


IN REACTION  6 , HOW MANY LITERS OF 'A' WILL COMBINE WITH  18
LITERS OF 'B'?

 |
 |
 |
 |
 |
IN THE SAME REACTION, HOW MANY LITERS OF 'C' CAN BE FORMED
FROM  19  GRAMS OF 'A' (AT STP)?
```

```
YOUR SCORE,ROBERT  IS  71.4 %.


READY
```

PROGRAM LISTING:

```
10DIMK(4),A(6,2),B(6,2),C(6,2)
11DIMP(40)
20PRINT"PLEASE TYPE YOUR FULL NAME"
25PRINT
27INPUT $P(M)
30IF P(M)=32 THEN 40                          ACCEPT STUDENT NAME
35IF P(M)=13 THEN 50
36GOTO41
40S=M
41M=M+1
45GOTO27
50PRINT
100FORJ=1 TO 2
105FOR I=1 TO 6
110READ A(I,J),B(I,J),C(I,J)
120NEXTI
125NEXTJ
130DATA342,222,156
131DATA73,87.8,34
132DATA170,58.5,85              REACTION WEIGHTS FOR SUBSTANCES
134DATA36,159.6,111.6           A, B, C IN EACH EQUATION
135DATA28,6,34
136DATA116,416,352
141DATA1,3,2,2,1,1,1,1,1,3,1,2,1,3,2,2,13,8      COEFFICIENTS IN EACH
150GOSUB2300                                     EQUATION ( A, B, C ONLY)
190T=0
195RANDOMIZE
200PRINT
210T=T+1
220IFT>2THEN250
225E=INT(RND(1)*4+1)
226IF E=S1 THEN 225            CHOOSE AN EQUATION TO WORK ON
227S1=E
230GOTO500
250E=INT(RND(1)*2+5)
260GOTO1700
500PRINT
```

```
505Q1=0
510V1=A(E,1)
511V2=B(E,1)         ARTIFICIAL FACTORS USED IN SOLVING PROBLEMS
512V3=A(E,2)         (DEALING WITH REACTANTS)
513V4=B(E,2)
514V5=V1/V3
515V6=V2/V4
520Q1=Q1+1
530GOSUB3500    SELECT PROBLEM TYPE
535GOSUB3535    SELECT NUMERICAL VALUES
545IFQ>2THEN550
546PRINT" GRAMS ";
547GOTO555
550PRINT" MOLES ";
555PRINT" OF SUBSTANCE 'A' REACT WITH "R   PRINT PROBLEM
560IF Q=1 THEN 570
561IF Q=4THEN 570
562PRINT" MOLES ";
563GOTO575
570PRINT" GRAMS ";
575PRINT" OF 'B'?"
580GOSUB1000    COMPUTE ANSWERS
600GOSUB800     MATH SUBROUTINE
610GOSUB2500    INPUT ANSWER, COMPUTE ERROR
620IFW<=0THEN650
625GOSUB700     FOR WRONG ANSWERS
630GOSUB1100    PRINT EXPLANATION
640GOTO535      NEW SET OF NUMBERS, TO REPEAT PROBLEM
650GOSUB750     FOR RIGHT ANSWERS
660IFQ1=1 THEN 520    SUPPRESS PROBLEM-TYPE DUPLICATION
670GOTO1500     SET UP FOR SECOND KIND OF PROBLEM
700X=X+1
705PRINT
710PRINT"NO-"     FOR WRONG ANSWERS
720RETURN
750PRINT
751C=C+1
760PRINT"RIGHT!!"        FOR RIGHT ANSWERS
770PRINT
780RETURN
800 PRINT
801PRINT
802PRINT"WANT MATH HELP (Y OR N)?";
805 INPUT $Z
810PRINT
812PRINT
815 IF Z=89 THEN 825
816 IF Z=#N THEN 925
820PRINT"PLEASE ANSWER Y OR N ";
821GOTO805
825PRINT"MULTIPLICATION OR DIVISION (M OR D)?";
830 INPUT $Z
831PRINT
835IF Z=77 THEN 875                                  MATH SUBROUTINE
837 IF Z<>#D THEN 825
840PRINT"DIVISOR=";
845INPUT D1
850PRINT"DIVIDEND=";
855 INPUT D2
860 PRINT D2"/"D1"="D2/D1
865PRINT"MORE HELP?";
870 GOTO805
```

```
875PRINT"FIRST NUMBER=";
876INPUT W
880PRINT"2ND NO.=";
881INPUT W1
885 P=W*W1
890PRINT W"X"W1"="W*W1
895GOTO865
925RETURN
1000M=V3/V4
1010K(1)=R*V1/V2
1015K(2)=R*M*V5                COMPUTE ANSWERS
1020K(3)=R*M
1025K(4)=R*M/V6
1030RETURN
1100PRINT
1105IFQ=4THEN1140
1106IF Q=3THEN 1130
1107IF Q=2 THEN 1120
1110PRINT"X:"R"="V1"GMS:"V2"GMS,SO X=("R")("V1")/"V2", OR "K(Q)
1115GOTO1150
1120PRINT"X MOLES:"R" MOLES="V3" MOLES:"V4"MOLES, X="K(Q)/V5"MOLES"   PRINT
1121PRINT"MULTIPLY THIS BY "V5"GMS PER MOLE, TO GET "K(Q)"GRAMS."     EXPLANA-
1122GOTO1150                                                          TIONS
1130PRINT"XMOLES:"R"MOLES="V3"MOLES:"V4"MOLES, X="K(Q)"MOLES"
1132GOTO1150
1140PRINT
1141PRINT"DIVIDE "R"GMS BY "V6" TO GET "R/V6"MOLES,"
1142PRINT"THEN X:"R/V6"="V3":"V4", SO X="K(Q)
1150PRINT
1165GOSUB2600
1166PRINT
1170RETURN
1500PRINT
1505Q2=0
1510V1=C(E,1)
1511V2=A(E,1)
1512V3=C(E,2)          SET UP FACTORS FOR SOLVING SECOND TYPE OF
1513V4=A(E,2)          PROBLEM (DEALING WITH PRODUCTS)
1514V5=V1/V3
1515V6=V2/V4
1516M=V3/V4
1520Q2=Q2+1
1530GOSUB3500
1535GOSUB3535
1545IFQ>2 THEN 1550
1546PRINT" GRAMS ";
1547GOTO1555
1550PRINT" MOLES ";
1555PRINT" OF 'C' ARE FORMED FROM "R          PRINT PROBLEM
1560IF Q=1 THEN1570
1561IF Q=4 THEN 1570
1562PRINT" MOLES ";
1563GOTO1575
1570PRINT" GRAMS";
1575PRINT" OF 'A'?"
1580GOSUB1000
1600GOSUB800
1610GOSUB2500
1620IFW<=0THEN1650
1625GOSUB700
1630GOSUB1100
```

```
1640GOTO1535
1650GOSUB750
1660IFQ2=1THEN1520
1670PRINT"OKAY,";
1671GOSUB3000
1675PRINT" LET'S TAKE A DIFFERENT REACTION:"
1680GOTO200
```

TRANSITION TO NEW EQUATION

```
1700PRINT
1705PRINT
1706R=INT(RND(1)*40+10)
1710PRINT"IN REACTION "E", HOW MANY LITERS OF 'A' WILL COMBINE WITH "R
1711PRINT"LITERS OF 'B'?"
1720K=R*A(E,2)/B(E,2)
1730GOSUB800
1735PRINT"ANS=";
1736INPUT Z
1740IF ABS(K-Z)<.02*K THEN 1780
1755GOSUB700
1760PRINT"THE SUBSTANCES ARE ALL GASES, SO:"
1762PRINT"X/"R"="A(E,2)"/"B(E,2)"   OR X="K
1767GOSUB2600
1775GOTO1700
1780GOSUB 750
1800PRINT
1810R=INT(RND(1)*10+10)
1820PRINT"IN THE SAME REACTION, HOW MANY LITERS OF 'C' CAN BE FORMED"
1821PRINT"FROM "R" GRAMS OF 'A' (AT STP)?"
1822A3=A(E,1)/A(E,2)
1825K=R/A3*C(E,2)/A(E,2)*22.4
1830GOSUB800
1840PRINT"ANS=";
1841INPUT Z
1845IF ABS(Z-K)<.02*K THEN1880
1855GOSUB 700
1860PRINTR"GMS OF 'A'="R"/"A3", OR "R/A3" MOLES OF 'A', THUS"
1861PRINT"X/"R/A3"="C(E,2)"/"A(E,2)", OR "K/22.4" MOLES OF 'C'"
1862PRINT"TIMES 22.4 LITERS/MOLE ="K"LITERS"
1866GOSUB2600
```

QUESTIONS 9 & 10

```
1867PRINT
1870GOTO1800
1880GOSUB750
1900PRINT
1905PRINT"YOUR SCORE,";
1906GOSUB3000
1907PRINT" IS "INT((C/(C+X)*100+.05)*10)/10"%."
1910PRINT
```

COMPUTE AND PRINT SCORE

```
1915PRINT
1920STOP
2300RANDOMIZE
2305PRINT"LET'S CHECK YOUR FORMULA WEIGHTS FIRST,";
2306GOSUB3000
2307PRINT
2310FORI=1TO3
2330W1=INT(RND(1)*2+1)
2331W2=INT(RND(1)*6+1)
2332IF W2=W3THEN2331
2334W3=W2
2335PRINT"GIVE THE FORMULA WEIGHT FOR '"CHR$(64+W1)"' IN EQ. #"W2;
2340INPUTZ
2345IFW1>1THEN2360
2350IFABS(Z-A(W2,1)/A(W2,2))<2THEN2380
2351GOTO2370
```

PRELIMINARY SPOT-CHECK FOR FORMULA WEIGHTS

```
2360IFABS(Z-B(W2,1)/B(W2,2))<2THEN2380
2370PRINT"WRONG -GO BACK AND CHECK YOUR WORK!!!"
2375STOP
2380NEXTI
2385RETURN
2500PRINT"ANS=";
2510INPUT Z                              ACCEPT ANSWER, COMPUTE ERROR
2520W=ABS(Z-K(Q))-.02*K(Q)
2530RETURN
2600PRINT
2605PRINT
2610PRINT"STUDY THAT, THEN HIT RETURN"    PAUSE TO STUDY EXPLANATION
2611INPUT$Z                                AFTER ERROR
2620RETURN
3000FOR J=0TOS
3010PRINT CHR$(P(J));     PRINT FIRST NAME
3020NEXT J
3030RETURN
3500Q=INT(RND(1)*4+1)
3510IF Q=S4 THEN 3500     CHOOSE PROBLEM TYPE
3520S4=Q
3525RETURN
3535IF Q=1 THEN3539
3536IFQ=4THEN3539
3537R=INT(RND(1)*30+10)/10                CHOOSE VALUES AND PRINT PROBLEM
3538GOTO3540
3539R=INT(RND(1)*100+50)
3540PRINT"IN EQ. #"E", HOW MANY ";
3550RETURN
4000END
```

DEFINITION OF VARIABLES:

A_{i1} - the reacting weight of substance A in the ith equation

B_{i1} - the reacting weight of substance B in the ith equation

C_{i1} - the reacting weight of substance C in the ith equation

A_{i2} - the coefficient of substance A in the ith equation

NOTE: The "reacting weight" is the formula weight times the coefficient in this particular reaction. No questions are asked about substance D in any equation, hence these weights are not stored.

P, M, S - used in setting up student's name

T - counter to determine how many equations have been used

E - number of current equation

S1 - number of previous equation

V1 - reacting weight of substance A in current equation

V2 - reacting weight of substance B in current equation

V3 - coefficient of substance A

V4 - coefficient of substance B

V5 - formula weight of substance A

V6 - formula weight of substance B

M - ratio (moles of A to moles of B)

R - number of moles or grams

Q - type of question to be asked (gm-gm, gm-mol, mol-mol, mol-gm)

W - one of two numbers to be multiplied (in math subroutine) and amount by which student answer exceeds 2% of correct answer

Z - student answer to current problem

K or K(Q) - correct answer to current question

MODIFICATION NOTES:

1. TO ELIMINATE THE QUESTIONS CONCERNING LITERS
   - Change statement 225 to read:
     `225 E = INT (RND(1)*6+1)`
   - Delete statement 220
   - Add statement 1665 to read:
     `1665 IF T=2 THEN 1900`
2. TO BYPASS MATH SUBROUTINE
   - Change 800 to read:
     `800 RETURN`
3. TO CHANGE REACTIONS
   - Change DATA statements 130 to 136 and statement 141

VIII: RAOULT

DESCRIPTION

This exercise affords practice in solving problems which concern the concentration of an aqueous solution, its freezing point, and the molecular weight of the solute.

While the questions in this program lead to a molecular weight determination by freezing point depression, the approach is designed to make students think about solutions in terms of moles of solute per 1000 units of solvent. This has further application in any discussion involving concentration.

DISCUSSION

QUESTION FORMAT: These problems are designed to aid the student in solving a problem of this form:

> THE FREEZING POINT OF AN AQUEOUS SOLUTION OF 'B' IS -2.76 DEGREES C. IF IT HAS 125 GRAMS OF 'B' DISSOLVED IN 750 GRAMS OF WATER, WHAT IS THE MOLECULAR WEIGHT OF 'B'?

Since the number of steps required to solve this type of problem overwhelms some students, it has been segmented into a sequence of questions:

1. 25.5 grams of 'A' in 650 grams of water are equivalent to how much 'A' in 1000 grams of water?
2. Substance 'A' has a molecular weight of 234. 35 grams of 'A' in 250 grams of water are equivalent to how many moles per 1000 grams of water?
3. Substance 'A' has a molecular weight of 432. 160 grams of 'A' in 1400 grams of water would freeze at what temperature?
4. The freezing point of an aqueous solution of 'B' is -4.78°C. How many moles of 'B' are dissolved per 1000 grams of water?
5. An aqueous solution of 'B' freezes at -1.05°C. If it has 236 grams of 'B' per 1000 grams of water, what is the molecular weight of 'B'?
6. An aqueous solution of 'B' freezes at -3.22°C. If it has 328 grams of 'B' in 1250 grams of water, what is the molecular weight of 'B'?

An explanation is given for each incorrect response, and the same type of question is asked again for reinforcement. In addition, if question 2 or 3 is missed, the program then goes back to question 1 and restarts the sequence. When question 5 or 6 is missed, the program starts over with question 4. This feature has been provided to insure that the student is able to put all the steps together in solving the total problem posed in the exercise.

SCORING: After questions 4 - 6 have been answered without an error, the score is printed. It is computed as follows:

$$\frac{T - X}{T} \times 100\%$$

where T = the total number of questions asked
X = the number of incorrect responses

PREPARATION

BACKGROUND: This exercise can be assigned as soon as colligative properties of solutions have been discussed. The terms "molality" and "mole fraction" need not have been explained as they are not used in any of the problems.

TIME REQUIREMENT: Approximately 40 minutes/student

DOCUMENTATION

SAMPLE RUN:

```
RAOULT   CANTERBURY

PLEASE TYPE YOUR FULL NAME.


ALEX COLVIN


Q. 1 .  SUBSTANCE 'A' HAS A MOLECULAR WEIGHT OF  431 ;
 39.1  GMS OF 'A' DISSOLVED IN  866 GMS OF WATER
ARE EQUIVALENT TO HOW MANY GRAMS OF 'A' IN 1000 GRAMS OF WATER?
```

```
WANT MATH HELP (Y OR N)?Y
MULTIPLICATION OR DIVISION (M OR D)?D
DIVISOR=?431
DIVIDEND=?866
 866 / 431 = 2.00928
MORE HELP?Y
MULTIPLICATION OR DIVISION (M OR D)?D
DIVISOR=?2.009
DIVIDEND=?1000
 1000 / 2.009 = 497.76
MORE HELP?N


ANS=?497.76
NO, ALEX
 39.1 IS TO  866  AS 'X' IS TO 1000, SO X= 39.1 TIMES 1000 OVER
 866  OR  45.15


STUDY THAT, THEN PRESS 'RETURN'.



Q. 2 .  SUBSTANCE 'A' HAS A MOLECULAR WEIGHT OF  373 ;
 27.2  GMS OF 'A' DISSOLVED IN  1475 GMS OF WATER
ARE EQUIVALENT TO HOW MANY GRAMS OF 'A' IN 1000 GRAMS OF WATER?


WANT MATH HELP (Y OR N)?Y
'
'
'
'
'
ANS=?188806
NO, ALEX
 27.2 IS TO  1475  AS 'X' IS TO 1000, SO X= 27.2 TIMES 1000 OVER
 1475  OR  18.4406


STUDY THAT, THEN PRESS 'RETURN'.



Q. 3 .  SUBSTANCE 'A' HAS A MOLECULAR WEIGHT OF  396 ;
 74.9  GMS OF 'A' DISSOLVED IN  191 GMS OF WATER
ARE EQUIVALENT TO HOW MANY GRAMS OF 'A' IN 1000 GRAMS OF WATER?


WANT MATH HELP (Y OR N)?Y
'
'
'
'
'
ANS=?392.146

CORRECT
```

```
Q. 4 .  SUBSTANCE 'A' HAS A MOLECULAR WEIGHT OF  118 ;
 79.4  GMS OF 'A' DISSOLVED IN  1369 GMS OF WATER
ARE EQUIVALENT TO HOW MANY MOLES OF 'A' PER 1000 G OF WATER?


WANT MATH HELP (Y OR N)?Y
|
|
|
|
ANS=?57.999

YOU DON'T SEEM TO BE STUDYING THE EXPLANATIONS!!
SORRY, THAT'S WRONG -

 79.4 GMS IN  1369 GMS OF WATER= 57.9985  IN 1000; DIVIDE THIS BY
 118  THE MOL. WT  TO GET THE MOLES PER 1000 G,  .491513


STUDY THAT, THEN PRESS 'RETURN'.



Q. 5 .  SUBSTANCE 'A' HAS A MOLECULAR WEIGHT OF  135 ;
 88.3  GMS OF 'A' DISSOLVED IN  1177 GMS OF WATER
ARE EQUIVALENT TO HOW MANY MOLES OF 'A' PER 1000 G OF WATER?


WANT MATH HELP (Y OR N)?Y
|
|
|
|

YOU DON'T SEEM TO BE STUDYING THE EXPLANATIONS!!
NO,ALEX
 88.3 GMS IN  1177 GMS OF WATER= 75.0213  IN 1000; DIVIDE THIS BY
 135  THE MOL. WT  TO GET THE MOLES PER 1000 G,  .555713


STUDY THAT, THEN PRESS 'RETURN'.



Q. 6 .  SUBSTANCE 'A' HAS A MOLECULAR WEIGHT OF  283 ;
 70.7  GMS OF 'A' DISSOLVED IN  1458 GMS OF WATER
ARE EQUIVALENT TO HOW MANY MOLES OF 'A' PER 1000 G OF WATER?

|
|
|
|
ANS=?.171346

RIGHT!!
```

```
Q. 7 .   SUBSTANCE 'A' HAS A MOLECULAR WEIGHT OF  215 ;
 12.2  GMS OF 'A' DISSOLVED IN  986 GMS OF WATER
ARE EQUIVALENT TO HOW MANY GRAMS OF 'A' IN 1000 GRAMS OF WATER?


WANT MATH HELP (Y OR N)?Y
 |
 |
 |
 |
ANS=?5.755E-2

YOU DON'T SEEM TO BE STUDYING THE EXPLANATIONS!!
NO, ALEX
 12.2 IS TO  986  AS 'X' IS TO 1000, SO X= 12.2 TIMES 1000OVER
 986  OR  12.3732


STUDY THAT, THEN PRESS 'RETURN'.


Q. 8 .   SUBSTANCE 'A' HAS A MOLECULAR WEIGHT OF  278 ;
 10  GMS OF 'A' DISSOLVED IN  838 GMS OF WATER
ARE EQUIVALENT TO HOW MANY GRAMS OF 'A' IN 1000 GRAMS OF WATER?


WANT MATH HELP (Y OR N)?Y
 |
 |
 |
 |
ANS=?11.9

CORRECT



Q. 9 .   SUBSTANCE 'A' HAS A MOLECULAR WEIGHT OF  195 ;
 14.9  GMS OF 'A' DISSOLVED IN  714 GMS OF WATER
ARE EQUIVALENT TO HOW MANY MOLES OF 'A' PER 1000 G OF WATER?


WANT MATH HELP (Y OR N)?Y
 |
 |
 |
 |
ANS=?.107

RIGHT!!
```

```
Q. 10 .  SUBSTANCE 'A' HAS A MOLECULAR WEIGHT OF  324 ;
 94.9  GMS OF 'A' DISSOLVED IN  1200 GMS OF WATER
WOULD FREEZE AT WHAT TEMPERATURE?

!
!
!
!


Q. 11 .
THE FREEZING POINT OF AN AQUEOUS SOLUTION OF 'B' IS -2.1  DEG.C
HOW MANY MOLES OF 'B' ARE DISSOLVED PER 1000GMS OF WATER?

!
!
!


Q. 12 .
THE FREEZING POINT OF AN AQUEOUS SOLUTION OF 'B' IS -3.2  DEG.C
IF IT HAS  115.2 GMS OF 'B' PER 1000GMS OF WATER, WHAT IS THE
MOLECULAR WEIGHT OF 'B'?

!
!
!
!


Q. 13 .
THE FREEZING POINT OF AN AQUEOUS SOLUTION OF 'B' IS -2  DEG.C
IF IT HAS  89.4 GMS OF 'B' IN  662 GMS OF WATER, WHAT'S THE
MOLECULAR WEIGHT OF 'B'?

!
!
!


OKAY,ALEX , YOUR SCORE IS  61.5 %

READY
```

PROGRAM LISTING:

```
5RANDOMIZE\DIMP(40)\PRINT"PLEASE TYPE YOUR FULL NAME."
6PRINT\PRINT
10INPUT$P(M)
15DIMP(40)
20IFP(M)=32THEN40\IFP(M)=13THEN50\GOTO41
40P1=M
41M=M+1
45GOTO10
50PRINT
100GOTO1100
```

INPUT NAME

```
200PRINT\M=INT(RND(1)*400+50)\PRINT\T=T+1
205PRINT"Q."T".  SUBSTANCE 'A' HAS A MOLECULAR WEIGHT OF "M";"
210R1=INT(RND(1)*1000+100)/10                               ESTABLISH
211R2=INT(RND(1)*2000+100)                                  VALUES FOR
220PRINTR1" GMS OF 'A' DISSOLVED IN "R2"GMS OF WATER"       AND PRINT
230RETURN                                                   Q. 1, 2, 3
300PRINT\PRINT\PRINT"ANS=";\INPUTZ   SUBROUTINE TO ACCEPT ANSWER
305E=ABS(Z-K)-.02*K\RETURN           AND COMPUTE ERROR
400PRINT\T=T+1\PRINT"Q."T"."
410R1=-INT(RND(1)*50+5)/10
411R2=INT(RND(1)*1000+500)/10        SUBROUTINE TO ESTABLISH VALUES
415R3=INT(RND(1)*2000+100)           FOR AND PRINT Q. 4 - 6
420PRINT"THE FREEZING POINT OF AN AQUEOUS SOLUTION OF 'B' IS "R1" DEG.C"
425RETURN
700X=X+1
701IFX/T<.7THEN710\IFT<3THEN710
702PRINT\PRINT"YOU DON'T SEEM TO BE STUDYING THE EXPLANATIONS!!"
710IFRND(2)>.5THEN 730
715PRINT"NO,";\GOSUB3000             FOR WRONG ANSWERS
720PRINT\GOTO740
730PRINT"SORRY, THAT'S WRONG -"
735PRINT
740RETURN
750FORJ=1TO5\PRINTCHR$(135);\NEXTJ\PRINT
751IFRND(1)>.5THEN770                   FOR RIGHT ANSWERS
755PRINT"RIGHT!!"\PRINT\GOTO780
770PRINT"CORRECT"\PRINT
780RETURN
800PRINT\PRINT
802PRINT"WANT MATH HELP (Y OR N)?";
805 INPUT $Z
810PRINT
815 IF Z=89 THEN 825
816 IF Z=#N THEN 925
820PRINT"PLEASE ANSWER Y OR N";
821GOTO805
825PRINT"MULTIPLICATION OR DIVISION (M OR D)?";
830 INPUT $Z
831PRINT                                          MATH SUBROUTINE
835IF Z=77 THEN 875
837 IF Z<>#D THEN 825
840PRINT"DIVISOR=";
845INPUT D1
850PRINT"DIVIDEND=";
855 INPUT D2
860 PRINT D2"/"D1"="D2/D1
865PRINT"MORE HELP?";
870 GOTO805
875PRINT"FIRST NUMBER=";
876INPUT W
880PRINT"2ND NO.=";
881INPUT W1
885 P=W*W1
890PRINT W"X"W1"="W*W1
895GOTO865
925RETURN
1100X1=0\GOSUB200
1120PRINT"ARE EQUIVALENT TO HOW MANY GRAMS OF 'A' IN 1000 GRAMS OF WATER
1125GOSUB800
1127K=R1*1000/R2
```

```
1130GOSUB300
1140IFE<0THEN1190
1145GOSUB700
1150PRINTR1"IS TO "R2" AS 'X' IS TO 1000, SO X="R1"TIMES 1000 OVER"
1151PRINTR2" OR "K                                  QUESTION 1 (1100 - 1195)
1155GOSUB1900
1160PRINT\GOSUB200
1170GOTO1120
1190GOSUB750
1195PRINT
1200GOSUB200
1220PRINT"ARE EQUIVALENT TO HOW MANY MOLES OF 'A' PER 1000 G OF WATER?"
1225GOSUB800
1227K=R1/R2*1000/M
1230GOSUB300
1240IFE<0THEN1290                                   QUESTION 2 (1200 - 1295)
1245X1=X1+1\GOSUB700
1250PRINTR1"GMS IN "R2"GMS OF WATER="K*M" IN 1000; DIVIDE THIS BY"
1251PRINTM" THE MOL. WT  TO GET THE MOLES PER 1000 G, "K
1255GOSUB1900
1260PRINT\GOSUB200
1270GOTO1220
1290GOSUB750
1295IFX1>0THEN1100
1300PRINT\GOSUB200
1320PRINT"WOULD FREEZE AT WHAT TEMPERATURE?"
1325GOSUB800
1327K=R1/R2*1000/M*1.86*(-1)
1330GOSUB300
1340IFE<2*(-.02*K)THEN1390                           QUESTION 3 (1300 - 1395)
1345X1=X1+1\GOSUB700
1350PRINTR1"GMS OF 'A' IN "R2"GMS OF WATER="R1/R2*1000" IN 1000, OR"
1351PRINTR1/R2*1000/M" MOLES PER 1000G, X 1.86 GIVES A F.P. OF "K
1355GOSUB1900
1360PRINT\GOSUB200
1370GOTO1320
1390GOSUB750
1395IFX1>0THEN1100
1400X1=0\GOSUB400
1420PRINT"HOW MANY MOLES OF 'B' ARE DISSOLVED PER 1000GMS OF WATER?"
1425GOSUB800
1427K=-R1/1.86
1430GOSUB300
1440IFE<0THEN1490                                   QUESTION 4 (1400 - 1495)
1445GOSUB700
1450PRINT"IF THE F.P. IS LOWERED 1.86 DEG. BY ONE MOLE, A DROP OF "-R1
1451PRINT"DEG. MEANS "R1"/1.86, OR "K" MOLES PER 1000 GMS OF WATER."
1455GOSUB1900
1460PRINT\GOSUB400
1470GOTO1420
1490GOSUB750
1495PRINT
1500GOSUB400
1520PRINT"IF IT HAS "R2"GMS OF 'B' PER 1000GMS OF WATER, WHAT IS THE"
1521PRINT"MOLECULAR WEIGHT OF 'B'?"
1525GOSUB800
1527K1=-R1/1.86\K=R2/K1
1530GOSUB300
1540IFE<0THEN1590
1545X1=X1+1\GOSUB700                                QUESTION 5 (1500 - 1595)
1550PRINT-R1"/1.86="K1"MOLES; "R2"GMS/"K1"="K", THE ANS."
1555GOSUB1900
```

```
1560PRINT\GOSUB400
1570GOTO1520
1590GOSUB750
1595IFX1>0THEN1400
1600GOSUB400
1620PRINT"IF IT HAS "R2"GMS OF 'B' IN "R3"GMS OF WATER, WHAT'S THE"
1621PRINT"MOLECULAR WEIGHT OF 'B'?"
1625GOSUB800
1627K1=-R1/1.86\K2=R2/R3*1000\K=K2/K1
1630GOSUB300
1640IFE<0THEN1690                                          QUESTION 6 (1600 - 1695)
1645X1=X1+1\GOSUB700
1650PRINTR2"GMS OF 'B' IN "R3"GMS OF WATER ="K2"GMS PER 1000. DIVIDE"
1651PRINT-R1" BY 1.86 TO GET "K1" MOLES PER 1000, SO THE MOL. WT. ="
1652PRINTK2"/"K1" OR "K
1655GOSUB1900
1660PRINT\GOSUB400
1670GOTO1620
1690GOSUB750
1695IFX1>0THEN1400
1800PRINT\PRINT\PRINT"OKAY,";\GOSUB3000
1805S=INT(((T-X)/T*100+.05)*10)/10                          COMPUTE, PRINT SCORE
1810PRINT". YOUR SCORE IS "S"%"
1820STOP
1900PRINT\PRINT\PRINT"STUDY THAT, THEN PRESS 'RETURN'."   PAUSE
1910INPUT$Z\RETURN
3000FORJ=0TOP1\PRINTCHR$(P(J));\NEXTJ\RETURN              PRINT FIRST NAME
4000END
```

DEFINITION OF VARIABLES:

M - molecular weight (between 50 - 450)

T - number of questions asked

R1,R2 - numerical values for problems

E - amount that error exceeds 2% of correct answer

X - number of errors

K - correct answer to current question

K1,K2 - values used in computing correct answer and explaining solution

Z - student response

X1 - 0, until question 2,3,5, or 6 has been missed; reset each time sequence restarts at question 1 or question 4

C - number of times three consecutive questions have been answered correctly

IX: MOLAR

DESCRIPTION

MOLAR is an exercise that deals with the relationships between the moles and grams of solute, and the volume and molarity of the solution.

DISCUSSION

QUESTION FORMAT: Four questions are asked, in this order:

1. IF *** ML OF SOLUTION CONTAIN *** GMS OF POTASSIUM HYDROXIDE, WHAT IS THE MOLARITY?
2. HOW MANY MOLES OF ACETIC ACID IN *** ML OF A *** MOLAR SOLUTION?
3. HOW MANY GRAMS OF NITRIC ACID ARE IN *** ML OF A *** MOLAR SOLUTION?
4. HOW MANY ML OF A *** MOLAR SOLUTION OF COPPER II SULFATE CONTAIN THE SAME NUMBER OF MOLES OF SOLUTE AS *** ML OF A SOLUTION OF SULFURIC ACID WHICH IS *** MOLAR?

The numbers which are inserted at the *** spaces vary at random over a reasonable range. The solute in each question is taken in order from a scrambled list of eight substances:

$NaOH$, KOH, HCl, $HC_2H_3H_2$, H_2SO_4, HNO_3, H_3PO_4, and $CuSO_4$

Math help is offered with each problem. If a student feels lost, he can decline the math help, type 0 (ZERO) in response to the problem, and receive an explanation. No error is counted against him. If a question is answered incorrectly, an explanation is given and a problem of the same form is given with a different substance and values.

NOTE: This program requires NOLINE on EduSystem 30.

SCORING: The score is given after the sequence has been completed three times. It is computed as follows:

$$\frac{Q - X}{Q} \times 100\%$$

where Q is the total number of questions and
X is the number of errors

PREPARATION

BACKGROUND: As soon as students start to use solution strengths in the laboratory and in problem solving, this exercise may be assigned.

The importance of carefully calculating the formula weights should be emphasized; the weights should be written on student guide sheets before running the exercise.

TIME REQUIREMENT: Approximately 30-45 minutes/student

DOCUMENTATION

SAMPLE RUN:

```
READY
NOLINE

READY
RUN


MOLAR   CANTERBURY

PLEASE TYPE YOUR FULL NAME


KEVIN HANNON


Q. 1

IF  1000 ML OF SOLUTION CONTAIN  11.5 GMS OF POTASSIUM HYDROXIDE
WHAT IS THE MOLARITY?


WANT MATH HELP (Y OR N)?Y
MULTIPLICATION OR DIVISION (M OR D)?D
DIVISOR=?56
DIVIDEND=?11.5
 11.5 / 56 = .205357
MORE HELP?N


ANS=?.205357


GOOD WORK!!
```

```
Q. 2

HOW MANY MOLES OF ACETIC ACID
IN  80 ML OF A  .59  MOLAR SOLUTION?


WANT MATH HELP (Y OR N)?Y
MULTIPLICATION OR DIVISION (M OR D)?M
FIRST NUMBER=?.08
2ND NO.=?.59
 8E-2 X .59 = 4.72E-2
MORE HELP?N


ANS=?4.72E-2


GOOD WORK!!


Q. 3

HOW MANY GMS OF NITRIC ACID
ARE IN  600 ML OF A  1.7
MOLAR SOLUTION?


WANT MATH HELP (Y OR N)?Y
 |
 |
 |
ANS=?64.26


RIGHT!!


Q. 4

HOW MANY ML OF A  .4 MOLAR SOLUTION OF COPPER II SULFATE
CONTAIN THE SAME NUMBER OF MOLES OF SOLUTE AS  120 ML OF A
SOLUTION OF SULFURIC ACID
WHICH IS  1.9  MOLAR?


WANT MATH HELP (Y OR N)?Y
 |
 |

ANS=?570


GOOD WORK!!


Q. 5

IF  1800 ML OF SOLUTION CONTAIN  45.5 GMS OF HYDROCHLORIC ACID
WHAT IS THE MOLARITY?
|
|
|
|
```

Q. 6

HOW MANY MOLES OF PHOSPHORIC ACID
IN 160 ML OF A 5E-2 MOLAR SOLUTION?

Q. 7

HOW MANY GMS OF POTASSIUM HYDROXIDE
ARE IN 550 ML OF A 1
MOLAR SOLUTION?

Q. 8

HOW MANY ML OF A 1.8 MOLAR SOLUTION OF ACETIC ACID
CONTAIN THE SAME NUMBER OF MOLES OF SOLUTE AS 150 ML OF A
SOLUTION OF NITRIC ACID
WHICH IS 1 MOLAR?

Q. 9

IF 650 ML OF SOLUTION CONTAIN 10.2 GMS OF COPPER II SULFATE
WHAT IS THE MOLARITY?

Q. 10

HOW MANY MOLES OF SULFURIC ACID
IN 240 ML OF A 1.74 MOLAR SOLUTION?

Q. 11

HOW MANY GMS OF HYDROCHLORIC ACID
ARE IN 50 ML OF A 1.7
MOLAR SOLUTION?

Q. 12

HOW MANY ML OF A .7 MOLAR SOLUTION OF PHOSPHORIC ACID
CONTAIN THE SAME NUMBER OF MOLES OF SOLUTE AS 150 ML OF A
SOLUTION OF SODIUM HYDROXIDE
WHICH IS 1 MOLAR?

PROGRAM LISTING:

```
5RANDOMIZE\DIMP(40)\PRINT"PLEASE TYPE YOUR FULL NAME"\PRINT\PRINT
10INPUT$P(M)
20IFP(M)=32THEN40\IFP(M)=13THEN50\GOTO41
40P1=M                                              ACCEPT STUDENT'S NAME
41M=M+1
45GOTO10
50PRINT
100FORI=1TO8
105READM(I)   STORE FORMULA WEIGHTS
110S(I)=INT(RND(1)*8+1)
120FORJ=1TOI-1                       SCRAMBLE LIST OF SOLUTES
125IFS(I)=S(J)THEN110
130NEXTJ
140NEXTI
150GOTO1100
190DATA40,36.5,98,60,63,160,98,56.1    FORMULA WEIGHTS
200IFS(I)=2THEN220\IFS(I)=3THEN230\IFS(I)=4THEN240\IFS(I)=5THEN250
205IFS(I)=6THEN260\IFS(I)=7THEN270\IFS(I)=8THEN280
210PRINT" SODIUM HYDROXIDE"\GOTO290
220PRINT"HYDROCHLORIC ACID"\GOTO290
230PRINT"SULFURIC ACID"\GOTO290          SUBROUTINE FOR PRINTING
240PRINT"ACETIC ACID"\GOTO290            NAME OF SOLUTE
250PRINT"NITRIC ACID"\GOTO290
260PRINT"COPPER II SULFATE"\GOTO290
270PRINT"PHOSPHORIC ACID"\GOTO290
280PRINT"POTASSIUM HYDROXIDE"\GOTO290
290RETURN
300PRINT\PRINT\PRINT"ANS=";\INPUTZ      ACCEPT ANSWER, COMPUTE ERROR
310E=ABS(Z-K)-.02*K\RETURN
350PRINT\PRINT\PRINT"STUDY THAT, THEN HIT 'RETURN'"
360INPUT$Z\RETURN                                          PAUSE
400PRINT\PRINT\Q=Q+1\PRINT"Q."Q\PRINT\RETURN     INCREMENT QUESTION COUNTER
700X=X+1
705IFRND(1)>.5THEN720
710PRINT"THAT'S NOT RIGHT, ";\GOSUB1900     TALLY ERROR, CHOOSE AND
715PRINT\GOTO730                            PRINT COMMENT
720PRINT"NO, THAT'S WRONG, "\PRINT
730RETURN
750PRINT\PRINT\IFRND(1)>.5THEN760
755PRINT"RIGHT!!"\GOTO770                   CHOOSE AND PRINT COMMENT ON
760PRINT"GOOD WORK!!"                       RIGHT ANSWER
770RETURN
800PRINT\PRINT
802PRINT"WANT MATH HELP (Y OR N)?";
805 INPUT $Z
810PRINT
815 IF Z=89 THEN 825
816 IF Z=#N THEN 925
820PRINT"PLEASE ANSWER Y OR N";
821GOTO805
825PRINT"MULTIPLICATION OR DIVISION (M OR D)?";
830 INPUT $Z
831PRINT                                                MATH HELP SUBROUTINE
835IF Z=77 THEN 875
837 IF Z<>#D THEN 825
840PRINT"DIVISOR=";
845INPUT D1
850PRINT"DIVIDEND=";
855 INPUT D2
```

```
860 PRINT D2"/"D1"="D2/D1
865PRINT"MORE HELP?";
870 GOTO805
875PRINT"FIRST NUMBER=";
876INPUT W
880PRINT"2ND NO.=";
881INPUT W1
885 P=W*W1
890PRINT W"X"W1"="W*W1
895GOTO865
925RETURN
1100GOSUB400
1110R1=INT(RND(1)*500+50)/10\R2=INT(RND(1)*40+2)*50
1115I=I+1\IFI<9THEN1120\I=I-8
1120PRINT"IF "R2"ML OF SOLUTION CONTAIN "R1"GMS OF ";\GOSUB200
1121PRINT"WHAT IS THE MOLARITY?"
1125GOSUB800
1127K=R1/R2*1000/M(S(I))
1130GOSUB300
1140IFZ=0THEN1150\IFE<0THEN1190\GOSUB700
1150PRINTR1"GMS IN "R2"ML= X GMS IN 1000 ML, WHERE X="R1/R2*1000"GMS"
1151PRINT"OR "K*M(S(I))"/"M(S(I))" MOLES/LITER, SO THE SOLUTION IS "K"M"
1155GOSUB350                                        QUESTION 1
1160PRINT\GOTO1110
1190GOSUB750
1200GOSUB400
1210R1=INT(RND(1)*50+1)*10\R2=INT(RND(1)*200+5)/100
1215I=I+1\IFI<9THEN1220\I=I-8
1220PRINT"HOW MANY MOLES OF ";\GOSUB200
1221PRINT"IN "R1"ML OF A "R2" MOLAR SOLUTION?"
1225GOSUB800                                          QUESTION 2
1227K=R1*R2/1000
1230GOSUB300
1240IFZ=0THEN1250\IFE<0THEN1290\GOSUB700
1250PRINT"MULTIPLY MOLARITY (MOLES PER LITER) BY VOLUME IN LITERS,"
1251PRINT"OR "R2"X"R1/1000"= THE ANSWER, "K
1255GOSUB350
1260PRINT\GOTO1210
1290GOSUB750
1300GOSUB400
1310R1=INT(RND(1)*30+1)*50\R2=INT(RND(1)*20+1)/10
1315I=I+1\IFI<9THEN1320\I=I-8
1320PRINT"HOW MANY GMS OF ";\GOSUB200\PRINT"ARE IN "R1"ML OF A "R2
1321PRINT"MOLAR SOLUTION?"
1325GOSUB800
1327K=R1*R2/1000*M(S(I))
1330GOSUB300                                          QUESTION 3
1340IFZ=0THEN1350\IFE<0THEN1390\GOSUB700
1350PRINT"MOLARITY TIMES LITERS GIVES MOLES; MOLES TIMES FORM. WT. GIVES
1351PRINT"GRAMS, SO: "R2"X"R1/1000"="R2*R1/1000"MOLES,"
1352PRINT"TIMES "M(S(I))" ="K" GRAMS"
1355GOSUB350
1360PRINT\GOTO1310
1390GOSUB750
1400GOSUB400
1410R1=INT(RND(1)*20+1)/10\R2=INT(RND(1)*20+1)*10
1411R3=INT(RND(1)*20+1)/10\IFR3=R1THEN1411
1415I=I+1\IFI<9THEN1420\I=I-8
1420PRINT"HOW MANY ML OF A "R1"MOLAR SOLUTION OF ";\GOSUB200
1421PRINT"CONTAIN THE SAME NUMBER OF MOLES OF SOLUTE AS "R2"ML OF A"
1422I=I+1\IFI<9THEN1424\I=I-8
```

```
1424PRINT"SOLUTION OF ";\GOSUB200\PRINT"WHICH IS "R3" MOLAR?"
1425GOSUB800                                              QUESTION 4
1427K=R2*R3/R1
1430GOSUB300
1440IFZ=0THEN1450\IFE<0THEN1490\GOSUB700
1450PRINT"FOR ANY SOLUTION, MOLARITY X VOLUME = MOLES, SO YOU CAN SAY"
1451PRINTR3" X "R2/1000"= V X "R1", SO V="K/1000"LITERS, OR "K"ML."
1455GOSUB350
1460PRINT\GOTO1410
1490GOSUB750
1500IFQ<10THEN1100  CHECK NUMBER OF QUESTIONS SO FAR - COMPUTE SCORE
1510S=INT(((Q-X)/Q*100+.05)*10)/10\IFS<75THEN1550
1520PRINT"NOT BAD, ";\GOSUB1900\PRINT"YOU SCORED "S"%."\PRINT\STOP
1550PRINT"NOT SO GOOD, ";\GOSUB1900\PRINT", YOUR SCORE IS "S"%."
1551PRINT"BETTER STUDY, THEN TRY AGAIN!"\PRINT\PRINT\STOP
1900FORJ=0TOP1\PRINTCHR$(P(J));\NEXTJ\RETURN
1999END

READY
```

DEFINITION OF VARIABLES:

S(i) - the ith substance in the scrambled arrangement of the eight solutes

Z - the student's response

K - the correct answer to each question

X - the number of errors

R1,R2,R3 - the numerical values for the problems

M(i) - the formula weight of the ith substance in the scrambled list

MODIFICATION NOTES:

1. TO CHANGE THE NAMES OF THE SUBSTANCES
    - Modify statements 190 and 210 to 280
2. TO CHANGE THE NUMBER OF QUESTIONS
    - Modify statement 1500
      or
    - Change statement 400 to read:
      400 IF Q = N THEN 1510 \ PRINT \ PRINT.....
      (where N = total number of questions to be run)

X: GASLAW

DESCRIPTION

Students solve ten problems concerning the relationships between temperature, pressure and volume of ideal gases. This program provides practice in applying Boyle's Law, Charles' Law and the Combined Gas Law.

DISCUSSION

QUESTION FORMAT: Each problem begins as follows:

A GAS OCCUPIES *** ML AT

followed by one of the expressions:

(A) *** DEGREES C. WHAT VOLUME WILL IT OCCUPY AT *** DEG. C?
(B) *** DEGREES C. AT WHAT CENTIGRADE TEMPERATURE WILL IT OCCUPY **** MILLITERS?
(C) *** MM PRESSURE. WHAT VOLUME WILL IT OCCUPY AT *** MM PRESSURE?
(D) *** MM PRESSURE. AT WHAT PRESSURE WILL IT OCCUPY *** ML?
(E) *** DEGREES C. AND *** MM PRESSURE. FIND ITS VOLUME AT S T P.

The numbers inserted at the *** are chosen at random. (Temperatures range from -50°C to 100°C, volumes lie between 50ml and 1550 ml, and pressures vary between 600mm and 800mm.)

SCORING: The student is given his score after the tenth question. He is then given the option to continue or stop.

The score is computed as follows:

$$\frac{10 - X}{10} \times 100\%$$

where X = the number of errors

PREPARATION

BACKGROUND: This exercise requires familiarity with the gas laws and understanding of the term "STP Conditions".

A common error involves the failure to change temperatures to Kelvin. In several places the program draws the student's attention to this, but it should be emphasized in class instructions.

TIME REQUIREMENT: 30-40 minutes/student

DOCUMENTATION

SAMPLE RUN:

```
GASLAW   CANTERBURY

PLEASE TYPE YOUR FULL NAME.

ALEX COLVIN


QUESTION # 1

A GAS OCCUPIES  208  ML AT -45  DEGREES CENT., AND  697  MM
PRESSURE. FIND ITS VOLUME AT S T P CONDITIONS.


WANT MATH HELP (Y OR N)?Y
MULTIPLICATION OR DIVISION (M OR D)?D
DIVISOR?228
DIVIDEND?208
 208 / 228 = .912281
MORE HELP?Y
MULTIPLICATION OR DIVISION (M OR D)?D
DIVISOR?.912281
DIVIDEND?697
 697 / .912281 = 764.019
MORE HELP?N
ANSWER (IN ML) IS?764

NO -
THIS IS WHERE YOU HAVE TO USE THE COMBINED GAS LAW -
V2=(P1)(V1)(T2)/(T1)(P2)      OR:
V2= 697 X 208 X 273/ 228 X 760   WHICH =  228.407  ML


STUDY THE EXPLANATION, THEN PRESS 'RETURN'
```

```
QUESTION # 2

A GAS OCCUPIES  151  ML AT  759  MM PRESSURE.
AT WHAT PRESSURE WILL IT OCCUPY  454 ML?


WANT MATH HELP (Y OR N)?Y
MULTIPLICATION OR DIVISION (M OR D)?1
MULTIPLICATION OR DIVISION (M OR D)?5
MULTIPLICATION OR DIVISION (M OR D)?M
FIRST NUMBER?151
2ND NUMBER?454
 151 X 454 = 68554
MORE HELP?Y
MULTIPLICATION OR DIVISION (M OR D)?D
DIVISOR?759
DIVIDEND?68554
 68554 / 759 = 90.3215
MORE HELP?N
ANSWER (IN MM) IS?90.3

NO -
USE BOYLE'S LAW LIKE THIS:  P2=(P1)(V1)/(V2) , OR
 P2= 759 X 151 / 454  WHICH = 252.442  MM


STUDY THE EXPLANATION, THEN PRESS 'RETURN'


QUESTION # 3

A GAS OCCUPIES  290  ML AT -28  DEGREES C.
WHAT VOLUME WILL IT OCCUPY AT  82  DEG. C?



WANT MATH HELP (Y OR N)?Y
|
|
|
|
|
|
 YOUR ANSWER, IN ML, =?420.2
THAT'S RIGHT!



QUESTION # 4

A GAS OCCUPIES  1247  ML AT  5  DEGREES CENT., AND  725  MM
PRESSURE. FIND ITS VOLUME AT S T P CONDITIONS.


WANT MATH HELP (Y OR N)?Y
|
|
|
|
|
ANSWER (IN ML) IS?2.471

THAT'S WRONG -
THIS IS WHERE YOU HAVE TO USE THE COMBINED GAS LAW -
V2=(P1)(V1)(T2)/(T1)(P2)      OR:
V2= 725 X 1247 X 273/ 278 X 760   WHICH =  1168.17  ML


STUDY THE EXPLANATION, THEN PRESS 'RETURN'


QUESTION # 5

A GAS OCCUPIES  1338  ML AT  658  MM PRESSURE.
AT WHAT PRESSURE WILL IT OCCUPY  151 ML?


WANT MATH HELP (Y OR N)?Y
MULTIPLICATION OR DIVISION (M OR D)?M
FIRST NUMBER?1338
2ND NUMBER?658
 1338 X 658 = 880404
MORE HELP?Y
MULTIPLICATION OR DIVISION (M OR D)?D
DIVISOR?151
DIVIDEND?880404
 880404 / 151 = 5830.49
MORE HELP?N
ANSWER (IN MM) IS?5830
ABSOLUTELY CORRECT!!




QUESTION # 6

A GAS OCCUPIES  376  ML AT  751  MM PRESSURE.
WHAT VOLUME WILL IT OCCUPY AT  797  MM PRESSURE?


|
|
|

QUESTION # 7

A GAS OCCUPIES  630  ML AT -44  DEGREES C.
WHAT VOLUME WILL IT OCCUPY AT  0  DEG. C?

|
|
|

QUESTION # 8

A GAS OCCUPIES  600  ML AT  37  DEG. C.
AT WHAT CENTIGRADE TEMPERATURE WILL IT OCCUPY  331  ML?

|
|
|
|
QUESTION # 9

A GAS OCCUPIES  92  ML AT  706  MM PRESSURE.
WHAT VOLUME WILL IT OCCUPY AT  668  MM PRESSURE?



QUESTION # 10

A GAS OCCUPIES  1390  ML AT  7  DEG. C.
AT WHAT CENTIGRADE TEMPERATURE WILL IT OCCUPY  808  ML?
```

PROGRAM LISTING:

```
10 DIM P(40)
20PRINT"PLEASE TYPE YOUR FULL NAME."
25PRINT
27INPUT $P(M)
30 IF P(M)=32 THEN 40
35 IF P(M)=13 THEN 50                        INPUT NAME
36 GOTO41
40S=M
41 M=M+1
45 GOTO 27
50 PRINT
60 GOTO300
300 I=I+1
305 IF I>10 THEN 2000     INCREMENT QUESTION COUNT, CHECK FOR 10
306 GOSUB 1000
307PRINT
308PRINT
310PRINT"QUESTION #"I
311PRINT                                 PRINT FIRST PART OF EACH QUESTION
315PRINT"A GAS OCCUPIES "V1" ML AT ";
320 IF RND(1)>.7 THEN 1500
325 IF RND(1)>.5 THEN 500        PICK A QUESTION 'TYPE'
330 IF RND(1)>.5 THEN 400
331A=A+1
332 IF A>2 THEN 320
340K=(V1*(T2+273))/(T1+273)
350PRINT T1 " DEGREES C."
351PRINT"WHAT VOLUME WILL IT OCCUPY AT "T2" DEG. C?"
353PRINT
354PRINT
360GOSUB800
365PRINT" YOUR ANSWER, IN ML, =";                  QUESTION A
366INPUT Z
370IF ABS(Z-K)<.02*K THEN 390
375GOSUB700
380PRINT"BE SURE YOU CHANGE THE TEMPERATURES TO K E L V I N - THEN"
381PRINT"USE CHARLES' LAW:  V2=(V1)(T2)/(T1)   OR"
382PRINT"      V2= "V1"X"T2+273"/"T1+273" WHICH = "K"ML"
383GOSUB3500
384PRINT
385PRINT
```

```
386GOTO300
390GOSUB750
395 GOTO 300
400B=B+1
401 IF B>2 THEN 320
402PRINTT1" DEG. C."
403PRINT"AT WHAT CENTIGRADE TEMPERATURE WILL IT OCCUPY "V2" ML?"
410GOSUB800
415K=(V2*(T1+273))/V1-273
420PRINT"ANSWER (DEG. C.) IS";
425INPUT Z                                          QUESTION B
435 IF ABS(Z-K)<.02*ABS(K) THEN 470
440GOSUB700
441IF ABS(Z-K-273)>2 THEN 447
442PRINT"YOU FORGOT TO CHANGE YOUR ANSWER TO CENTIGRADE, ";
443GOSUB3000
444PRINT
445PRINT"YOU SHOULD HAVE SUBTRACTED 273! THEN ANSWER IS "K "DEG C"
446GOTO300
447PRINT"USING CHARLES' LAW, T2=(V2)(T1)/(V1), WE HAVE:"
448PRINT"T2="V2"X"T1+273"/"V1" OR "K+273" DEG. K, OR "K" DEG C."
450GOSUB3500
460GOTO300
470GOSUB 750
475GOTO300
500 IFRND(1)>.5 THEN 600
501 C=C+1
502 IF C>2 THEN 320
505K=P1*V1/P2
510PRINTP1" MM PRESSURE."
511PRINT"WHAT VOLUME WILL IT OCCUPY AT "P2" MM PRESSURE?"
520GOSUB800
525PRINT"ANSWER (IN ML) IS";
526INPUT Z
530IF ABS(Z-K)<.02*K THEN 570
535GOSUB 700                                        QUESTION C
540 PRINT"USE BOYLE'S LAW FOR THIS ONE, ";
541GOSUB3000
542PRINT"     -  V2 = (P1)(V1)/(P2)"
543PRINT" OR V2="P1"X"V1"/"P2" WHICH = "K" ML"
550GOSUB3500
560GOTO300
570GOSUB750
575GOTO300
600D=D+1
601 IF D>2 THEN 320
602K=P1*V1/V2
610PRINTP1" MM PRESSURE."
611PRINT"AT WHAT PRESSURE WILL IT OCCUPY "V2"ML?"
620GOSUB800
625PRINT"ANSWER (IN MM) IS";
630INPUT Z
635IF ABS(Z-K)<.02*K THEN 670                       QUESTION D
640GOSUB700
645PRINT"USE BOYLE'S LAW LIKE THIS:  P2=(P1)(V1)/(V2) , OR"
646PRINT" P2="P1"X"V1"/"V2" WHICH =" K" MM"
650GOSUB3500
660GOTO300
670GOSUB750
675GOTO300
```

```
700PRINT
701X=X+1
702IF RND(1)>.5 THEN 710
705PRINT"NO -"
706GOTO720
710PRINT"THAT'S WRONG -"
720RETURN
```

FOR WRONG ANSWERS

```
750IF RND(1)>.9 THEN 775
751IF RND(1)>.6 THEN 765
752IF RND(1)>.5 THEN 760
753PRINT"THAT'S RIGHT!"
754GOTO790
760PRINT"ABSOLUTELY CORRECT!!"
761GOTO790
765FOR Q=1 TO 10
766PRINT CHR$(135);
767NEXT Q
768PRINT"RIGHT!!!"
769GOTO790
775PRINT"GOOD WORK,";
776GOSUB3000
777GOTO790
790PRINT
791PRINT
792RETURN
```

FOR RIGHT ANSWERS; RINGS BELL, GIVES A VARIETY OF REMARKS

```
800PRINT
801PRINT
802PRINT"WANT MATH HELP (Y OR N)?";
805 INPUT $Z
810PRINT
815 IF Z=89 THEN 825
816 IF Z=#N THEN 925
820PRINT"PLEASE ANSWER Y OR N";
821GOTO805
825PRINT"MULTIPLICATION OR DIVISION (M OR D)?";
830 INPUT $Z
831PRINT
835IF Z=77 THEN 875
837 IF Z<>#D THEN 825
840PRINT"DIVISOR";
845INPUT D1
850PRINT"DIVIDEND";
855 INPUT D2
860 PRINT D2"/"D1"="D2/D1
865PRINT"MORE HELP?";
870 GOTO805
875PRINT"FIRST NUMBER";
876INPUT W
880PRINT"2ND NUMBER";
881INPUT W1
885 P=W*W1
890PRINT W"X"W1"="W*W1
895GOTO865
925RETURN
```

MATH SUBROUTINE

```
1000 RANDOMIZE
1010 V1=INT(RND(1)*1500+50)
1020V2=INT(RND(1)*1500+50)
1030T1=INT(RND(1)*150-50)
1040T2=INT(RND(1)*150 - 50)
1050P1=INT(RND(1)*200+600)
1060 P2=INT(RND(1)*200+600)
1099 RETURN
```

SUBROUTINE TO ESTABLISH VALUES FOR PROBLEMS. NOTE: K, THE CORRECT ANSWER TO A PROBLEM, IS COMPUTED; IT IS NOT FROM THIS SET

```
1500E=E+1
1501 IF E>2 THEN 325
1502PRINT T1" DEGREES CENT., AND "P1" MM"
1503PRINT"PRESSURE. FIND ITS VOLUME AT S T P CONDITIONS."
1510K=P1*V1*273/((T1+273)*760)
1520GOSUB800
1525PRINT"ANSWER (IN ML) IS";
1530INPUT Z
1535IF ABS(Z-K)<.02*K THEN  1590
1545GOSUB 700
1550PRINT"THIS IS WHERE YOU HAVE TO USE THE COMBINED GAS LAW - "
1555PRINT"V2=(P1)(V1)(T2)/(T1)(P2)      OR:"
1556PRINT"V2=" P1"X"V1"X 273/"T1+273"X 760   WHICH = "K" ML"
1560GOSUB3500
1575GOTO300
1590GOSUB 750
1595 GOTO300
```

QUESTION E

```
2000 IF X=0 THEN 2100
2005PRINT
2006PRINT
2010PRINT"WELL, ";
2020GOSUB3000
2030PRINT"  YOUR SCORE IS "(10-X)/10*100 " %"
2040PRINT"WANT TO TRY MORE (Y OR N)?";
2050INPUT $Z
2060PRINT
```

COMPUTE, PRINT SCORE

```
2070IF Z=#N THEN 2090
2071I=0
2072PRINT
2073PRINT
2074X=0
2075A=0
2076B=0
2077C=0
2078D=0
2079E=0
2080GOTO300
2090STOP
```

RESET VARIABLES

```
2100PRINT
2110PRINT"GOOD WORK,";
2115GOSUB3000
2120PRINT" - YOUR SCORE IS 100%"
2130STOP
```

PRINT SCORE FOR PERFECT SET OF PROBLEMS

```
3000FOR J=0 TO S
3010 PRINT CHR$(P(J));
3020 NEXT J
3030 RETURN
```

PRINT FIRST NAME

```
3500PRINT
3510PRINT
3520PRINT"STUDY THE EXPLANATION, THEN PRESS 'RETURN'"
3521INPUT $Z
3530RETURN
4000END
```

PAUSE TO STUDY EXPLANATIONS

DEFINITION OF VARIABLES:

P,M,S,J - used in inputing and printing student's name

Z - student's response

K - the correct answer to the current question

X - the number of errors

I - the number of questions

A,B,C,D,E - the number of times each question has been asked

P1,P2,V1,V2,T1,T2 - the values generated for the problems

P,W,D1,D2,W1 - used in the math help subroutine

Q - an artificial variable used to ring the bell on the teletype

MODIFICATION NOTES:

1. TO REDUCE THE NUMBER OF QUESTIONS FOR EACH RUN
   - Modify statements 305 and 2030
2. TO BYPASS THE MATH HELP SUBROUTINE (FOR SLIDE RULE PRACTICE)
   - Change statement 800 to read:
     800 RETURN

APPENDIX A: MODIFICATION PROCEDURES

Because all the programs in this collection were designed for and tested with EduSystem 30, certain modifications may be required for other BASIC systems.

To illustrate the changes which can be effected to adapt to a different system, PERIOD and EQUATIONS have been modified for EduSystem 20 at the end of this appendix.

I. LINE NUMBERS

EduSystem 30 allows line numbers up to 4096. If the numbers in a program are too large for your system, they must be changed; all the GOTO and GOSUB statements must be modified accordingly. In most cases an entire block of code can be copied as a unit by changing the first digit in the line number. For example, statements 2300 - 2385 in EQUATIONS can be changed to 1300 - 1385; statement 150 in that program would then be changed to GOSUB 1300.

II. OPTIONAL LET STATEMENT

EduSystem 30 BASIC permits a LET statement to be written in either of these two ways:

```
10 LET A - 4
   or
10 A = 4
```

The second format has been used in these exercises; consult your user's guide to determine conventions of your system.

III. USE OF STRING VARIABLES

Extensive use has been made of the single-character string variable feature of EduSystem 30 to attain a more comfortable, conversational atmosphere for the student as he works through the exercises.

This feature is used in the student name routine, the math help subroutine, and the subroutine for providing explanations to problems.

SYSTEMS WITH NUMERIC INPUT ONLY

In general, a system which does not accommodate strings will require that each statement of the type;

```
INPUT $Z
```

be changed to:

```
INPUT Z
```

with an appropriate specification for the allowable values for Z, such as:

```
PRINT "TYPE 1 FOR YES, 0 FOR NO"
```

STUDENT NAME: The entire routine can be deleted or bypassed using a GOTO statement. Where student identification is desired, numerical code can be substituted. Thus the statement which reads:

```
20 PRINT "PLEASE TYPE YOUR FULL NAME"
```

can be changed to:

```
20 PRINT "PLEASE TYPE YOUR STUDENT NUMBER"

25 INPUT S
```

and the statement which prints the score can be changed to:

```
1500 PRINT "OKAY, STUDENT "S", YOUR SCORE IS........
```

MATH HELP: Since this subroutine is an integral part of each problem solving exercise, the modified version (without strings) has been reproduced here:

```
800PRINT\PRINT\PRINT"NEED MATH HELP (1 FOR YES, 0=NO)";\INPUTZ

805IF Z=0THEN925

825PRINT"MULTIPLICATION (1) OR DIVISION (2)";\INPUTZ

830IFZ=1THEN875

840PRINT"DIVISOR=";

845INPUT D1

850PRINT"DIVIDEND=";

855INPUT D2

860PRINT D2"/"D1"="D2/D1

865PRINT"MORE HELP (1 =YES, 0=NO)";\INPUTZ\GOTO805
```

```
866PRINT

870GOTO805

875PRINT"FIRST NUMBER=";

876INPUT W

880PRINT"2ND NO.=";

881INPUT W1

885P=W*W1

890PRINT W"X"W1"="W*W1

895GOTO865

925PRINT\PRINT\RETURN
```

EXPLANATION: The subroutine that stops the program and prints the explanation can be changed as follows:

```
2500 PRINT\PRINT\PRINT"STUDY THE EXPLANATION, THEN TYPE '9'"\INPUT Z
```

SYSTEMS WHICH SUPPORT MULTIPLE CHARACTER STRINGS

Statements like INPUT $Z must be changed to INPUT Z$.

Specific changes in the student name routine depend on the characteristics of the BASIC compiler (some have a limit of six characters, others have virtually no limit). For those with a 6 character limit, the INPUT instruction can be used to accept the entire name. The user's guide for your system should be consulted to determine the specific language requirements.

EduSystem 30 allows the use of the symbol # with any character to represent the ASCII code of that character. Thus

```
LET 2 = #N  is equivalent to
LET 2 = 78
```

If this # convention is not available on your system, statements such as

```
333 K = #L  in PERIOD
```

must be changed to

```
333 K = 76
```

EQUATIONS

```
2RANDOMIZE
50PRINT
100C(1)=23
110C(2)=39.1
115C(3)=107.9
120C(4)=24.3
125C(5)=40.1
130C(6)=137.3
135C(7)=27
140A(1)=35.5
145A(2)=79.9
150A(3)=127
155A(4)=16
160A(5)=32
165A(6)=79
200GOTO1200
400PRINT"HOW MANY GRAMS OF ";\GOSUB1110
415PRINT" COMBINE WITH "L" MOLES OF ";\GOSUB1130\PRINT "ATOMS"
420PRINT\PRINT\GOSUB800\PRINT"ANSWER=";\INPUTZ
430IFABS(Z-K3)<.02*K3THEN490\GOSUB700
440PRINT"SINCE THE ATOM RATIO IS "X" TO "Y" YOU NEED "X/Y" TIMES "L
441PRINT" MOLES OF ";\GOSUB1110
450PRINT " OR "X/Y*L" TIMES "C(I)" GRAMS, OR "K3\GOSUB600
455GOTO 1665
490GOSUB750\GOTO1665
500I=INT(RND(1)*7+1)
520J=INT(RND(1)*6+1)
530L=INT(RND(1)*8+2)/10
540N=INT(RND(1)*500+100)
550RETURN
600PRINT
601PRINT
602PRINT"STUDY THAT, THEN INPUT 9 TO CONTINUE THE PROGRAM"\INPUTZ
604RETURN
700X1=X1+1
710PRINT"NO-"
720RETURN
750IF RND(1)>.5 THEN 757
755PRINT"RIGHT!!"
756GOTO770
757PRINT"OKAY!!"
770RETURN
800PRINT\PRINT\PRINT"NEED MATH HELP (1 FOR YES, 0=NO)";\INPUTZ
805IF Z=0THEN925
825PRINT"MULTIPLICATION (1) OR DIVISION (2)";\INPUTZ
830IFZ=1THEN875
840PRINT"DIVISOR=";
845INPUT D1
850PRINT"DIVIDEND=";
855INPUT D2
860PRINT D2"/"D1"="D2/D1
865PRINT"MORE HELP (1 =YES, 0=NO)";\INPUTZ\GOTO0805
866PRINT
```

```
870GOTO805
875PRINT"FIRST NUMBER=";
876INPUT W
880PRINT"2ND NO.=";
881INPUT W1
885P=W*W1
890PRINT W"X"W1"="W*W1
895GOTO865
925PRINT\PRINT\RETURN
950IFQ<3THEN1200\IFX1<3THEN980
955PRINT(12-X1)/12*100"%ISN'T GOOD ENOUGH, TRY SOME MORE!"
960Q=0\X1=0\GOTO1200
980PRINT(12-X1)/12*100"% IS A PRETTY GOOD SCORE"
990STOP
1110IF I=1THEN1510
1111IF I=2 THEN1520
1113IF I=3 THEN 1530
1114IF I=4 THEN 1540
1115 IF I=5 THEN 1550
1116 IF I=6 THEN 1560
1117 IF I=7 THEN 1570
1120RETURN
1130 IF J=1 THEN 1610
1132IF J=2 THEN 1620
1133 IF J=3 THEN 1630
1134 IF J=4 THEN 1640
1135 IF J=5 THEN 1650
1136 IF J=6 THEN 1660
1140 RETURN
1200GOSUB500
1205IFI<4THEN1230
1210IFI<7THEN1225
1215IFJ<4THEN1850
1220GOTO1900
1225IFJ<4THEN1800
1226GOTO1700
1230IFJ<4THEN1700
1231GOTO1750
1240PRINT\C=X*C(I)\T=X*C(I)+Y*A(J)\K1=C/T*100\K2=X/Y*(I+J)
1241K3=L*X/Y*C(I)\K4=N/A(J)*X/Y*C(I)
1250Q=Q+1\PRINT"CONSIDER THE COMPOUND FORMED BY ";\GOSUB1110
1255PRINT" AND ";\GOSUB1130\PRINT\PRINT
1260PRINT"WHAT PERCENT IS ";
1261GOSUB1110\PRINT"? (HINT: WRITE THE FORMULA DOWN FIRST!!)"
1262PRINT\PRINT\GOSUB800\PRINT"ANSWER=";\INPUTZ
1270IFABS(Z-K1)<.02*K1THEN1290
1271GOSUB700\PRINT"DIVIDE THE MASS OF ";\GOSUB1110
1272PRINT" IN THE COMPOUND, "C" BY THE FORMULA WT.,"T" TO GET"K1/100
1273PRINT"WHICH IS "K1"PERCENT"\GOSUB600
1275GOTO1300
1290GOSUB750\PRINT\GOTO1300
1300PRINT"HOW MANY MOLES OF ";
1310GOSUB1110
1320PRINT"COMBINE WITH "I+J" MOLES OF ";
1325GOSUB1130
1330PRINT" ATOMS TO FORM IT";
1335INPUTZ
1340IF ABS(Z-K2)<.02*K2THEN1390
1345GOSUB700
1350PRINT"THE RATIO OF ATOMS OF ";
1351GOSUB1110
```

```
1352PRINT" TO ATOMS OF ";
1353GOSUB1130
1354PRINT" IS "X" TO "Y
1356PRINT" SO THE ANSWER IS "K2
1358GOSUB600
1360GOTO400
1390GOSUB750
1395PRINT\GOTO400
1510PRINT"SODIUM"
1511GOTO1120
1520PRINT"POTASSIUM"
1521GOTO1120
1530PRINT"SILVER"
1531GOTO1120
1540PRINT"MAGNESIUM"
1541GOTO1120
1550PRINT"CALCIUM"
1551GOTO1120
1560PRINT"BARIUM"
1561GOTO1120
1570PRINT"ALUMINUM"
1571GOTO1120
1610PRINT"CHLORINE"
1611GOTO1140
1620PRINT"BROMINE"
1621GOTO1140
1630PRINT"IODINE"
1631GOTO1140
1640PRINT"OXYGEN"
1641GOTO1140
1650PRINT"SULFUR"
1651GOTO1140
1660PRINT"SELENIUM"
1661GOTO1140
1665PRINT"HOW MANY GRAMS OF ";\GOSUB1110
1666PRINT" COMBINE WITH "N" GRAMS OF ";\GOSUB1130\PRINT"?"
1670PRINT\PRINT\GOSUB800\PRINT"ANSWER=";\INPUTZ
1675IFABS(Z-K4)<.02*K4THEN1690
1676GOSUB700\PRINTN " GMS OF ";\GOSUB1130
1680PRINT" IS "N"/"A(J)" OR "N/A(J)" MOLES, SO YOU NEED "
1681PRINTX"/"Y" TIMES "N/A(J)" MOLES OF ";\GOSUB1110
1683PRINT"WHICH ="X/Y*(N/A(J))" TIMES "C(I)" GRAMS, OR "K4 "GRAMS"
1685GOSUB600\GOTO950
1690GOSUB750\GOTO950
1700X=1
1710Y=1
1720GOTO1240
1750X=2\Y=1\GOTO1240
1800X=1\Y=2\GOTO1240
1850X=1\Y=3\GOTO1240
1900X=2\Y=3\GOTO1240
1950FORJ=0TOP1\PRINTCHR$(P(J));\NEXTJ\RETURN
1999END
```

PERIOD

```
  5 DIM P(60)
 15 PRINT"USE A PERIODIC TABLE TO ANSWER THESE QUESTIONS"
 20 PRINT
 50 PRINT
102 DIM A(5,8)
105 W=2
110 FOR I=1 TO 2
115 FOR J=1 TO 8
120 W=W+1
125 A(I,J)=W
130 NEXT J
140 NEXT I
150 FOR I=3 TO 5
155 FOR J= 1 TO 2
157 A(I,J)=(I-2)*18+J
160 NEXT J
162 NEXT I
165 FOR I=3 TO 5
167 FOR J= 3 TO 8
170 A(I,J)=(I-2)*18+10*(INT(I/5)+1)+4*(INT(I/5))+J
172 NEXT J
175 NEXT I
180 X=0
181 Q=0
182 C=0
200 F=0
205 GOSUB1860
210 Q=Q+1
220 PRINT"GIVE THE AT. NO. OF AN ELEMENT WITH PROPERTIES LIKE ELEMENT"
221 PRINT" NUMBER"A(I,J)
222 PRINT
223 PRINT
230 INPUT Z
235 FOR L=1 TO 5
236 IF L=I THEN 245
240 IF Z=A(L,J) THEN 280
245 NEXT L
250 IF F=1 THEN 260
251 GOSUB1100
255 PRINT"TRY AGAIN"
256 GOTO230
260 X=X+1
265 PRINT"NO-SIMILAR PROPERTIES MEANS SAME FAMILY, I.E. SAME COLUMN!"
270 GOTO205
280 GOSUB1150
285 PRINT
286 PRINT
300 GOSUB 1600
310 Q=Q+1
320 PRINT"IS THE IONIZATION ENERGY OF ELEMENT # "A(I1,J1) "GREATER (1)"

321 PRINT"OR LESS (0) THAN ELEMENT #"A(I2,J1)
322 PRINT
323 PRINT
325 PRINT"TYPE 1 FOR GREATER,0 FOR LESS"
330 INPUTZ
331 PRINT
```

```
332 IF I2>I1 THEN 336
333 K=0
334 GOTO 338
336 K=1
338 GOTO340
340 IF Z=K THEN 380
350 GOSUB1100
365 PRINT"IONIZATION ENERGY DECREASES AS VALENCE ELECTRONS ARE "
366 PRINT"FURTHER AND FURTHER FROM THE NUCLEUS"
370 GOTO300
375 PRINT
376 PRINT
380 GOSUB1150
385 PRINT
386 PRINT
400 F=0
405 GOSUB1500
410 Q=Q+1
420 PRINT"GIVE THE AT. NO. OF AN ELEMENT WITH THE SAME NUMBER OF"
421 PRINT"OUTER SHELL ELECTRONS AS ELEMENT #"A(I,J)
422 PRINT
423 PRINT
430 INPUT Z
435 FOR L=1 TO 5
436 IF L=I THEN 445
437 L1=L
440 IF Z=A(L,J) THEN 480
445 NEXT L
450 IF F=1 THEN 460
451 GOSUB1100
455 PRINT"TRY AGAIN"
456 GOTO430
460 X=X+1
465 PRINT"NO,";
467 PRINT", IT HAS TO BE IN THE SAME FAMILY, LIKE #"A(L1,J)
470 GO TO 405
475 PRINT
476 PRINT
480 GOSUB1150
485 PRINT
486 PRINT
500 GOSUB1700
510 Q=Q+1
520 PRINT"IS  THE ION. EN. OF ELEMENT"A(I1,J1)"> OR < ELEMENT"A(I1,J2)
521 PRINT"TYPE 1 FOR GREATER, 0 FOR LESS"
522 PRINT
530 INPUTZ
531 IF J1>J2 THEN 536
532 K=0
534 GOTO538
536 K=1
538 PRINT
539 PRINT
540 IF Z=K THEN 580
550 GOSUB1100
565 PRINT"ION. ENERGY GENERALLY INCREASES AS YOU MOVE TO THE RIGHT"
570 GO TO 500
575 PRINT
576 PRINT
580 GOSUB1150
585 PRINT
586 PRINT
```

```
600 RANDOMIZE
601 I=INT(5*RND(1)+1)
602 J=INT(7*RND(1)+1)
603 IFJ=4THEN 602
604 IF J=5THEN602
610 PRINT"WHAT IS THE MOST LIKELY OXIDATION STATE FOR ELEMENT #"A(I,J)
615 Q=Q+1
622 PRINT
623 PRINT
626 INPUT Z
630 IF J>4 THEN 633
631 K=J
632 GOTO640
633 K=J-8
640 IF Z=K THEN 660
642 GOSUB1100
644 IF K<0 THEN 648
645 PRINT"NO-SINCE IT TENDS TO LOSE"K"ELECTRONS THE ANSWER IS +"K
646 GOTO600
648 PRINT"IT CAN FILL AN OCTET WITH"ABS(K)"ELECTRONS, SO THE ANS IS"K
650 GOTO600
660 GOSUB1150
680 GOTO900
900 PRINT
910 PRINT
915 IF Q<10 THEN 200
920 IFC/Q<.85 THEN 950
925 PRINT (Q-X)/Q*100"% IS A PRETTY GOOD SCORE,";
930 PRINT" WANT MORE? YES=1, NO=0"
934 INPUTZ
936 IFZ=1THEN200
941 PRINT
942 STOP
950 PRINTX"ERRORS OUT OF"Q"ISN'T TOO GOOD,";
952 PRINT", SO TRY THESE"
953 PRINT
954 PRINT
955 GOTO180
1100 X=X+1
1105 F=1
1110 PRINT"WROMG"
1120 RETURN
1150 PRINT
1155 PRINT"CORRECT"
1156 C=C+1
1160 RETURN
1500 RANDOMIZE
1510 I=INT(5*RND(1))+1
1520 J=INT(8*RND(1))+1
1530 RETURN
1600 RANDOMIZE
1610 I1=INT(5*RND(1)+1)
1620 I2=INT(5*RND(1)+1)
1630 IF I2=I1 THEN 1620
1640 J1=INT(8*RND(1)+1)
1650 RETURN
1700 RANDOMIZE
1710 I1=INT(5*RND(1)+1)
1720 J1=INT(8*RND(1)+1)
1730 IF J1=2 THEN 1720
```

```
1740 IF J1=6 THEN 1720
1750 J2=INT(8*RND(1)+1)
1760 IF J2=J1 THEN 1750
1770 IF J2=6 THEN 1750
1780 IF J2=2 THEN 1750
1790 RETURN
1800 IF Z=#G THEN 1850
1810 IF Z=#L THEN 1850
1820 PRINT"PLEASE ANSWER G FOR GREATER, L FOR LESS"
1830 INPUT$Z
1835 PRINT
1850 RETURN
1860 RANDOMIZE
1870 I=INT(5*RND(1)+1)
1875 J=INT(7*RND(1)+1)
1890 RETURN
1999 END
```

APPENDIX B: TEXTBOOK REFERENCE GUIDE (By Chapter)

EXERCISE	Brown - "GENERAL CHEMISTRY", Merrill, 1968	CBA Group - "CHEMICAL SYSTEMS", Webster/McGraw-Hill, 1964	Cotton - "CHEMISTRY - AN INVESTIGATIVE APPROACH", Houghton Mifflin, 1968	Dorf - "MASTERING MODERN CHEMISTRY", Oxford Book Company, 1968	Dorin - "MODERN PRICIPLES OF CHEMISTRY", College Entrance Book Company, 1967	Garrett - "CHEMISTRY", Ginn, 1966	Greenstone - "CONCEPTS IN CHEMISTRY", Harcourt, Brace Jovanivich, 1970	Metcalfe - "MODERN CHEMISTRY", Holt, Rinehart & Winston, 1966/70	O'Connor - "CHEMISTRY - EXPERIMENTS AND PRINCIPLES", D. C. Heath, 1968	Parry - "CHEMISTRY - EXPERIMENTAL FOUNDATIONS", Prentice-Hall, 1970	Quagliano - "CHEMISTRY", Prentice-Hall, 1969	Sienko and Plane - "CHEMISTRY - 3rd Edition", McGraw-Hill, 1966	Smoot - "CHEMISTRY - A MODERN COURSE", Merrill, 1971	Thomson - "CHEMISTRY - AN INTRODUCTION TO MATTER", Addison-Wesley, 1973	Toon - "FOUNDATIONS OF CHEMISTRY", Holt, Rinehart & Winston, 1968
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DENSITY	1	1	2	1	1	2	1 5	1	1	1	2	1	1	3	2
ELECTRON	5	10	8	4	4	8	3	3 4	9	15	12	3	7	14	8
ATOM	6	10	8	4	4	8	3	4	9	15	12	3	7	14	8
PERIOD	6	10	6	4	6	9	5	5	7 9	8 15	12 13	3	18 9	14	9
COMPOSITION	4	3	4	6	9	10 11	7 11	7	2 3	2 3	4	5	5	8 9	4
EQUATIONS	4	3	4 11	6	9	11	7 11	8 10	3	3	4	5	5	9	4
RAOULT	10	13	10	8	8	15	12	12	6	5	19	10	14	18	11
MOLAR	10	3	10	6	8	15	12	12 14	6	5	19	10	14	18	4
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